

THE URINARY TRACT IN PREGNANCY
AND THE PUERPERIUM
WITH SPECIAL REFERENCE TO
PYELITIS OF PREGNANCY

BY

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EXPLANATORY NOTE.

The thesis is accompanied by two appendices,

A, consisting of illustrations

and

**B, consisting of case records and
temperature charts.**

It has been necessary to reduce the X-Ray plates to quarter plate size, so that the deformities of the urinary tract shown in them are less striking than in the original and, as some detail has been lost in reproduction, the photographs should be examined in a good light.

Only the records of the more important cases used to illustrate the text have been given in detail, with temperature charts where necessary.

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This study of the urinary tract in pregnancy and the puerperium is based on the results of six years of clinical research. I have attempted a comprehensive investigation of the subject, in the tradition described by Sir Thomas Lewis in his Harveian Oration as "a tradition that Clinical Science shall not be confined narrowly or by artificial boundaries, but shall be free to search how and where it will: a tradition which will not countenance attempts to separate the study of health from disease, or the study of animals from that of man, or work at the bedside from that of the laboratories". For this purpose I have correlated the findings of clinical, urological, bacteriological and pathological investigations.

It has been known for a long time that dilatation of the ureters and renal pelves occurs during pregnancy, but the only available method of study in the human being was post-mortem examination until recently, when the advances in urological methods have enabled us to study those changes in the living subject, and to obtain much valuable information about functional as well as anatomical variations. This information has explained many of the clinical symptoms associated with these changes and has led

to important advances in prevention and treatment of pathological conditions. Moreover, investigation of the functional variations in pregnancy throws light on the essential nature of the activities of the urinary tract and suggests that many changes for which one attempted to find an organic basis depend upon alteration in endocrine balance.

The work has been carried out over a period from October 1927 - October 1933, in the wards and research laboratory of the Glasgow Royal Maternity and Women's Hospital and in the gynaecological and urological departments of the Glasgow Royal Infirmary. I wish to take this opportunity of acknowledging my indebtedness to Professor James Hendry and Professor J.M. Munro Kerr for their encouragement and the generous way in which they have allowed me free access to clinical material. All the work has been carried out personally, with the exception of the routine bacteriological methods which were done under my supervision by the technician during the last two years, when I have been acting as pathologist in charge of the laboratory. To quote Sir Thomas Lewis again, "it is essential that those who have had charge of patients and

have studied phenomena in the living should themselves and not through skilled deputies, explore the tissue changes which may underlie disturbed function: for while the skilled deputy may more accurately describe and name these changes in the tissues upon which he chances he cannot enjoy either full opportunities or the full inspiration to correlate function and structure. It is by these correlations that the meaning of many manifestations during life are explained".

CHAPTER I.

THE ANATOMY AND PHYSIOLOGY OF THE UPPER URINARY TRACT.

I. Anatomy.

(a) The renal pelvis.

(b) The ureter.

II. Physiology.

Results of animal experiments.

Results of investigation in man.

(1) by pyeloscopy and ureteroscopy.

(2) by intravenous pyelography.

(3) by hydrophoragraph.

(4) effect of drugs on the urinary tract.

Bibliography.

Before considering the changes which occur in the urinary tract in pregnancy, it is essential to have a clear idea of the anatomy and physiology of the urinary tract of which I shall now give a short description, with a review of the most recent work and opinions on the subject.

I. ANATOMY.

(a) The renal pelvis.

Our views on the different types of renal pelvis found in man have changed very considerably in the last few years as a result of pyelography and the study of kidneys removed at operation. There are two basic types - Ampullary, consisting of a pelvis proper and 2 or more major calyces, from which a variable number of minor calyces arises, and

Bifid, in which there is absence of the pelvis proper due to the fact that the ureter divides almost immediately into 2 major calyces which divide into a variable number of minor calyces.

There are many variations of these basic types as well as

transitions from one to the other. Major calyces usually are 3 in number and minor usually 8. Each minor calyx consists of a narrow neck or canal connecting it with the major calyx, from which it arises, and an expanding terminal portion or fornix with a cup-shaped depression to receive one of the papillae of the parenchyma.

Histology. The wall of the renal pelvis and its calyces consists of 3 layers, epithelial, muscular and outer fibrous. These are continuous with the coats of the ureter. The muscle fibres are arranged in 2 layers, an inner longitudinal and an outer circular. The average capacity of the renal pelvis is 7.5 ccs. Harris (1930) believes that there is a muscular ring round the base of each calyx, major and minor, having a sphincter action. This is difficult to show histologically although it seems probable from the study of function.

Nerve Supply. The chief source of nerve supply to the kidney is from the renal plexus which receives branches from (a) the 11th and 12th spinal nerves, (b) sympathetic fibres arising from the coeliac axis and semilunar ganglion, and (c) the splanchnic and vagus. There is a specially rich nerve supply to the calyces. The renal nerves are in

intimate relation with those of the ureter, bladder and genitalia, so that stimulation in this peripheral area may reflexly influence the kidneys. It seems likely that the reverse may be the case and that stimulation of the renal tract may influence the genitalia, notably the uterus. This is referred to on page 297.

Lymphatic Drainage. The lymphatic vessels form a network in the cortex and medulla of the kidney surrounding the tubules and blood-vessels and drain into lymph nodes round the aorta. Those in the cortex communicate freely with the perirenal area. They also communicate with the lymphatics of the periureteral sheath so that infection may spread to the kidney or perirenal fat from below.

(b) The ureter.

The length of the ureter varies from 28 to 34 cms. and it is divided into abdominal and pelvic portions. The abdominal portion is 13 to 14 cms. long and stretches from the ureteropelvic junction to the point where it crosses the iliac vessels. The pelvic portion stretches from this point to its insertion into the bladder. The juxtavesical portion is the name given to the last 2 to 3 cms. of the

pelvic portion. The intramural portion (the part traversing the wall of the bladder) is about 2 cms. long.

The ureter in its lumbar and iliac portions lies in contact with the aponeurosis of the psoas muscle about one finger's breadth from the spine. In front it is in intimate contact with the posterior peritoneum. The ureter has a wide range of mobility in its abdominal portion and it is important to bear this in mind when considering the changes which occur in pregnancy.

At the pelvic brim the ureters cross the iliac vessels obliquely where the common iliac artery divides into the internal and external divisions. At this point there is a difference in the two sides owing to the difference in the course of the common iliac vessels. The right common iliac vessels cross the vertebral column from left to right and therefore lie more anteriorly than the left. The right ureter has to cross over the right common iliac vessels almost at right angles to gain the pelvis, so that it has a more exposed course than the left, which is partly protected by the promontory of the sacrum, and the sigmoid colon and its mesentery which lie anterior to it. On the pelvic floor it enters the base of the

broad ligament, crossing the uterine artery and continues downwards and mesially in the vicinity of the cervix to the vagina. Its terminal portion lies embedded in the connective tissue between the bladder and the vagina close to the anterior vaginal wall, from which point it bends sharply forwards to penetrate the bladder wall obliquely. According to Brash (1922), there is often a long pre-vaginal portion on the left side, whereas the right ureter may not lie close to the vagina. In these cases the left ureter will be more liable to injury.

Histology. There are 3 coats, the outer fibrous, the middle muscular and the inner epithelial. The adventitia consists chiefly of connective tissue. The muscular consists of an inner longitudinal and an outer circular coat. In the lower portion of the ureter there are added the longitudinal fibres of the ureteral sheath. The submucosa is a loose connective tissue with some elastic fibres. This tissue is also found between the muscle bundles of the muscular layer. The ureter is lined by transitional epithelium.

Fuchs (1926) says that from the examination of 50 autopsies he finds that at the point of physiological

narrowing the texture of the submucosa is less loose than in the other areas but the muscular coats are not so well developed. This, he states, is the cause of the resistance to distension in these narrow areas. According to E.A. Schafer (1929), the wall of the ureter in its upper two thirds contains a large amount of connective tissue between the muscle bundles, so that the wall is by no means so purely muscular as is the case in most hollow viscera. In the uppermost third the amount of connective tissue nearly equals the bulk of muscular structure. In the middle third the circular fibres are more developed, while in the lower or pelvic portion the connective tissue is relatively scanty and the whole wall becomes more muscular, with the muscle bundles extending almost to the epithelium. Near the lower end the ureter is ensheathed by a number of longitudinally arranged muscle bundles which appear to be continuous from the bladder wall but are in reality a development of the outer longitudinal muscular layer of the ureter itself, the ureter sheath. The muscle bundles of the ureter sheath are somewhat coarser than the rest of this part of the ureter and are separated from it by a cleft in the connective tissue.

The lymphatics run in the wall of the ureter and also in the sheath. They lie between the epithelial lining and the muscular coats. It is commonly held that both groups of lymphatics, i.e. in the wall and in the sheath, communicate longitudinally with those of the kidney and bladder and horizontally with the lumbar and pelvic lymph nodes.

Nerve Supply. In its upper part the ureter is supplied from the renal plexus and in its middle and lower portions from the upper sacral ganglion and from the inferior hypogastric and vesical plexuses. These fibres anastomose freely. McMyn (1929) is of the opinion that the ureter cannot be compared to the intestine or oesophagus and that there is no plexus in the wall of the ureter. He holds that the contractions of the ureter arise in the muscle fibres themselves independent of intrinsic or extrinsic nerves and are propagated by the direct contact of the muscle fibres. Artificial stimulation of the ureter causes peristaltic waves in both directions. On the other hand, many authors claim to have demonstrated the presence of ganglia in the wall of the ureter. Protopopow (1897) investigated the fine structure

of the ureter and demonstrated rich nerve plexuses and numerous ganglia in the wall. This is supported by the experimental work of Hofbauer and Timbres (1928) who found that nicotine had a paralysing effect on the activity of excised ureters. Blatt (1928) states that peristalsis of the ureter and kidney pelvis is regulated by neuroganglionic motor centres placed in its wall. Kuntz (1929) says that the ureter is abundantly supplied by nerves of sympathetic and parasympathetic origin but that their rôle is as yet little understood. Hurst (1930) is also of the opinion that the wall of the ureter contains a nerve plexus with very numerous ganglion cells.

II. PHYSIOLOGY.

The physiology of the kidney pelvis and ureter may be studied in numerous ways in animals and human beings; in animals by direct vision of the ureters in situ or more commonly by observation of excised ureters either in toto or in isolated strips; in human beings by direct vision at laparotomy, by chromocystoscopy, pyelography and pyeloscopy and by graphic records obtained by apparatus

attached to the ends of a ureteral catheter.

Results of animal experiments.

As early as 1869, Engelmann described in detail the nature of peristaltic contractions in the ureter. He observed that contractions normally originate in the kidney pelvis and proceed towards the bladder, that the contractions are independent of intrinsic or extrinsic nerves and that the impulse to contract is conveyed directly from one muscle fibre to another. Sokoloff and Luchsinger (1881) passed physiological salt solution through the ureters under varying pressures and noted the effect upon peristalsis. The greater the pressure of fluid passing through the lumen of the ureter the more frequent and vigorous the peristaltic waves became. A practical application of this finding is the treatment by abundant fluids in conditions of stasis and infection of the urinary tract. More recently Pflaumer (1919), Quinby (1922) and Boeminghaus (1923) confirmed the fact that the amount of urine excreted by the kidney influences the peristaltic activity of the ureter by altering its degree of distension. Protopowpow (1897) showed that

stimulation of the splanchnic nerve caused increased ureteral peristalsis, whereas section of the same nerve inhibited peristalsis. This agrees with the findings of Balath (1925) that sympathectomy caused complete relaxation of the ureter. Lucas (1906), Macht (1917) and Satani (1919¹) by studying the ureter graphically either in situ or with excised strips have shown that it contains sympathetic and autonomic nerve fibres. Satani (1919²) believes that the most important causes of ureteral peristalsis are reflex stimulation of the motor nerves, direct mechanical distension of the ureteral musculature and local reflex stimulation by the salt content of the urine.

More recently, Trattner (1932) described accurately the movements of the ureter studied in dogs, both in situ and in excised portions. He also describes the movements of the human ureter, exposed at operation under spinal anaesthesia. According to him the peristaltic waves consist of (a) longitudinal contractions which shorten the ureter and narrow it but do not obliterate the lumen, and (b) a circular contraction which momentarily obliterates the lumen in successive segments of the organ as the wave advances. The degree of

shortening and narrowing of the ureter by the longitudinal contractions and the degree of encroachment on the ureteral lumen by the circular contractions is dependent on the tone of the ureteral musculature and the strength of the contractions. When activity occurs the longitudinal contraction quickly involves the whole organ, while the circular contraction can be seen involving successive segments of the organ. When the circular wave has dissipated itself complete relaxation occurs. Both circular and longitudinal contractions usually begin at the kidney end and work to the bladder. They may move in the opposite direction (antiperistalsis) under certain circumstances. The amplitude, rate and rhythm of contractions vary considerably, the amplitude from 2 to 3 cms. to 8 to 10 cms, water pressure, the rate from 1 contraction every 2 to 3 minutes to 1 every 5 to 6 seconds and the rhythm from being regular with either long or short pauses between the contractions to complete irregularity. The ureter may be divided into an upper, middle and lower third, since these separate divisions frequently assume independent contractions, so that a contraction may begin in the middle or lower third of the ureter and be followed by peristalsis

of the entire organ. This power of independent movement of the different segments of the ureter has been proved by many observers, Lucas (1908), Satini (1919²), Boeminghaus (1923), Hryntschak (1925), Gruber (1928), Hofbauer (1928²), Blatt (1929), Gruber (1930) and Trattner (1932).

Following nephrectomy the remaining stump has been observed to contract by Graves and Davidoff (1923) and Boeminghaus (1923). During cystoscopic examination I have observed the pulling up of the ureteral orifice on the side where the kidney had been excised. Lucas (1908) observed that where the ureter is ligated peristalsis continues in the lower segment but at a slower tempo than in the upper segment. Binet and Stoiceso (1931) observed that even partial denuding of the ureter or longitudinal slitting does not stop ureteral contractions.

It has been stated by various authors, Blum (1925), Haebler (1922), Quinby (1922), that the pacemaker for the rhythmic contractions of the ureter lies in the renal pelvis and calyces. It has been shown that the upper third of the ureter contracts more often and is more easily excited than the rest of the ureter. The lower third is least easily stimulated and contracts most slowly. It is therefore

easier for the peristaltic waves to travel from the renal pelvis to the bladder than in the opposite direction. The fact that antiperistalsis has never been observed to occur spontaneously in a normal ureter may be explained on that basis. Under abnormal circumstances reverse peristalsis may occur, e.g. pinching the ureter at any point will induce peristaltic waves to start from this point in both directions. Such stimuli as alterations in the hydrogen-ion concentration of the urine, alterations in temperature, stimulation of the hypogastric nerve, pressure on the bladder, etc. have all produced reverse peristalsis experimentally. Clinically there is the evidence of retrograde movement of ureteral calculi and the fact that in performing a catheter pyelogram the introduction of a small quantity of sodium iodide slowly into the lower end of the ureter will almost immediately be conveyed to the kidney pelvis and give a satisfactory shadow on X-Ray examination. As regards regurgitation from the bladder, Lewin and Goldschmidt (1893) observed that when they injected a coloured solution under moderate pressure into the bladder the contents regurgitated in many cases into both ureters. Other workers repeated

those experiments and held that reverse peristalsis was nearly always responsible for this. Sampson (1903) however, in a series of 20 dogs, was unable to produce reverse peristalsis in the normal ureter. When a cannula was inserted into the ureterovesical orifice and salt solution injected into the ureter, it responded by peristalsis, not by antiperistalsis. Kretschmer (1918) found by means of radiograms in the human subject that opaque substances put into the bladder may find their way to the kidney, but Wislocki and O'Connor (1920) working with rabbits conclude that it is very doubtful whether reverse peristalsis is ever the cause of this phenomenon. They found that with a moderate bladder retention, where the bladder tone is good, the ureterovesical sphincter is occasionally prevented from closing and the intravesical pressure projects a column of fluid into the ureters. Cunningham and Graves (1924) opened the abdomen in animals under light anaesthesia and filled up the bladder with methylene blue and were able to observe the occurrence of regurgitation. They came to the conclusion that the chief factor in its production lies in the bladder being of active tone, so that it responds to increased distension

by tonic contraction which opens the ureterovesical orifice, sufficiently to allow regurgitation to occur, especially in the presence of obstruction at the vesical neck.

The ureters at first attempt to overcome the backward flow by increased activity, and are successful to begin with but gradually the contractions grow less effective and finally cease. In the type of bladder which is so lacking in tone that tonic contraction fails to appear on filling, no regurgitation occurs. The tension produced in this type is a purely mechanical distension. These experimental findings are important in the consideration of the possibility of ascending infection of the urinary tract in the puerperium (see page 350). Gibbs (1929), working with fowls, found that the tone of the ureter prevented reflux. According to Barksdale (1930), reflux along the ureters from the bladder is more common during pregnancy than in the non-pregnant, e.g. 7 non-pregnant dogs showed no reflux when the bladder had been filled up with sodium iodide at a pressure of 45 to 60 mms. Hg., whereas 5 out of 6 pregnant dogs showed reflux and 3 of these tested sometime postpartum showed no reflux.

Wislocki and O'Connor (1920), using animals, have studied the effect of partial and complete obstruction of the ureter. After partial ligation the lumen increases in diameter and the muscle hypertrophies above the obstruction. Peristaltic waves are more frequent and more vigorous than is seen in the normal ureter. This was found also by Binet and Stoiceso (1931). Vigorous anti-peristaltic movements, if not spontaneous, can be elicited by pinching the ureter. The ureter below the obstruction exhibits normal spontaneous peristaltic contractions. In the case of complete obstruction there is seldom any spontaneous peristalsis nor does it react to stimuli. When however part of the contained fluid is released violent peristaltic and antiperistaltic movements begin. They also studied the effect of ureteral catheters and noticed that normal peristaltic waves stopped at the tip of the catheter. If solutions were run in through the catheter the peristaltic waves became more frequent and more vigorous. If the injection pressure was increased the ureter became distended and the peristalsis ceased entirely. Smith and Ockerblad (1927), working with dogs, found a 50 per cent. increase in length of the ureter after

partial obstruction. This developed very quickly and caused kinking which in their opinion was due to the fact that the vessels running in the wall of the ureter would not stretch. Those kinks do not cause symptoms. They also found the amount of muscle in proportion to epithelium and connective tissue is increased above the obstruction both where the total thickness of the wall of the ureter is greater than normal and also where it is less. The muscle bundles which normally are loosely bound together by connective tissue are now tightly packed together. The individual muscle bundles seem larger and there is also increase in their number. According to Hurst (1930), obstruction may occur at the ureterovesical orifice, due to a lack of relaxation of the sphincter and this may be due in some cases to degenerative changes in the nerve plexuses in the adventitia of this portion of the wall of the ureter. This might result from deep seated inflammation, e.g. cellulitis. A peristaltic wave may in some cases not be able to force the closed sphincter but usually increased peristalsis overcomes the obstruction; if not, stasis and dilatation occur.

These results of partial obstruction in the

ureters of dogs described by Smith and Ockerblad are of the greatest importance, as the deformities produced in the ureter are similar to those occurring in the right ureter in women in the second half of pregnancy. This is strong evidence in favour of the view that partial obstruction to outflow occurs in the human ureter at the level of the pelvic brim in the second half of pregnancy. I have shown in Chapter III that in pregnant women no hypertrophy of the ureteral musculature occurs above the point of obstruction, suggesting that some other factor prevents this physiological response to obstruction. This explains why such marked degrees of dilatation occur so quickly as the result of the relatively moderate pressure which can be exerted by the pregnant uterus.

Results of investigation in man.

(1) Pyeloscopy and Ureteroscopy. By screening after filling with an opaque medium the movements of the kidney pelvis and ureters are observed, but it is open to the objection that catheterisation of the ureters is necessary and the introduction of a hypertonic solution required,

which may cause hypertonus to the degree of spasm or in some cases a temporary paralysis. Some interesting results, however, have been obtained by numerous observers, mostly French. Hryntschak (1927) says that pyeloscopy is valuable as an aid to pyelography, as by seeing when the kidney pelvis is full one can avoid overdistension. He states that the normal emptying time of the kidney pelvis is 8 minutes. Herbst (1931) by means of pyeloscopy has shown that the upper calyx is first to discharge into the kidney pelvis, followed by the others in succession from above downwards. The upper part of the ureter is then filled by the contraction of the kidney pelvis, which has meantime been in diastole. The characteristic shadow of the filled portion of the ureter is called the ureteral spindle and can be seen advancing along the ureter, taking from 1 to 5 seconds to reach the bladder. In the case of obstruction, the spindle is seen to be thrown back from that point and gradually fill up the ureter above or it may simply hesitate and gradually ooze through the narrowed portion before the next wave comes along. Where there are dilatation and atony of the ureter, due to neurogenic or

inflammatory lesions, the ureter appears filled and remains in this condition for some time. Under normal conditions only a part of the ureter is filled at one time. Cumming (1930), by means of serial photographs taken every 30 seconds, has reached the same conclusions. He showed that what might appear to be a narrowing of the ureter, if only one plate were taken, is really either the upper or lower end of a peristaltic wave in progress along the ureter.

(2) Intravenous Pyelography. In contradistinction to the older method of retrograde pyelography, intravenous pyelography enables us to study function under more or less physiological conditions. Although it has only been in use for a few years, the results of numerous investigations have been published. Lichtenberg (1931) commented on the fact that uroselectan, the opaque medium most commonly used, is excreted by the kidney glomeruli, so that where there is glomerular damage the shadow is faint, and that in pyogenic parenchymatous infections no shadow may be seen at all. Conditions causing retention of urine and primary tubular damage give good shadows, even in advanced stages. The only contra-indications to the use of this method

according to Roth and Wright (1930), Heritage and Ward (1930), Lichtenberg (1931) are anuria, uraemia and gross liver damage. The subjective symptoms of faintness, flushing and increased pulse rate which followed the use of the early preparations are no longer encountered with Uroselectan B. Thirst due to the intense diuresis is sometimes complained of and tenderness along the course of the injected vein.

Intravenous pyelography is not however a certain method of studying the function or the dynamics of the upper urinary tract, as (a) disturbance of kidney function may so retard excretion of uroselectan that a distinct shadow of the kidney pelvis and ureter is not obtained, and (b) in a normal urinary tract the uroselectan is so quickly swept away that the whole ureter is never full at one time and a complete shadow of it is not obtained in a single pyelogram. Compression of the lower end of the ureter mechanically improves visualisation but upsets physiological conditions. However, as will be seen later, this actually does occur during normal pregnancy and makes intravenous pyelography and ureterography give particularly good representations of the urinary tract.

The time of appearance of the calyces gives some idea of kidney function but, as has been pointed out already, in the non-pregnant state intravenous pyelography is unreliable in the study of ureter function. Nevertheless, Guichard (1932) has used it to study the function of the ureter by means of screening. He supports the findings of Legen (1914) which were obtained by catheter pyelography, but was unable to observe the contractions which the latter held emptied the calyces into the kidney pelvis. He was of the opinion that many of the phenomena observed by those using retrograde pyelography were spasmodic effects.

(3) Hydrophoragraph. The most satisfactory method of studying ureteral function seems to be the hydrophoragraph of Trattner (1932). A catheter is inserted into the ureter and connected up to a recording apparatus, so that every contraction of the ureter is recorded on a revolving drum. As the ureter contracts the lever rises and when it relaxes the lever falls. The pressure against which the ureter is expelling urine can be regulated, so that the activity of the ureter at any pressure can be studied. The

accumulation of urine secreted by the kidney is drained off by an automatic valve, so that pressure conditions are kept constant. Trattner found by this apparatus that at any point along its entire length the ureter is capable of contracting and may be stimulated into activity by mechanical, chemical or electrical means. If stimulated at the renal end, the contraction wave proceeds towards the bladder, and if stimulated at the bladder end, the wave proceeds towards the kidney. If stimulation occurs anywhere between the kidney pelvis and bladder, the contraction wave proceeds towards both kidney and bladder from the point stimulated. According to Trattner, the longitudinal or circular muscle may go into spasm separately or simultaneously. If the longitudinal muscle alone is spastic, the flow of urine may be diminished or retarded. Gibbs (1929) observed that in fowls spasm of the ureter not only retarded the flow of urine but also held up renal secretion, and he suggested that the tone of the ureter governed to some extent the rate of renal secretion. Trattner states that spasm of the circular muscle only affects small portions of the ureter and stops the flow of

urine entirely. In longitudinal spasm the level of the lever remains constant and no impulse is recorded. In circular spasm the level of the lever falls gradually, since the intra-ureteric pressure drops and the ureter fills up with fluid from the catheter. Spasm may be due to a catheter and this will disappear in a few minutes, or it may be due to the injection of a hypertonic solution. It may occur as the result of inflammation. According to Harris (1930), spasm may occur at the base of any of the calyces or at the uretero-pelvic junction, due in his opinion to overaction of the sympathetic. This spasm may be the cause of delayed emptying of a calyx and may constitute the beginning of a hydronephrosis. Those spasms produce severe pain which responds as a rule to eserine, at least temporarily. Harris has employed perirenal sympathectomy in 28 cases of renal pain with very encouraging results, the response to eserine being used as a diagnostic test.

In experiments on dogs, Trattner found that the ureter contracts only when working against a pressure, the

optimum being 3 to 18 cms. water, and that the crucial level, i.e. the level of pressure beyond which there was marked reduction in the amplitude of the contractions, was very little more than the optimum.

A most useful method of estimating the efficiency of the ureter is that called by Trattner "the motor test". When the hydrophoragraph is connected up to a ureteral catheter in situ and there is no evidence of spontaneous peristaltic activity, then it is not known whether the ureter is quiescent, spastic or hypotonic. The motor test is employed to find out which condition is present. It consists of injecting, according to the size of the ureter, 3 to 10 ccs. of saline into the ureter through the catheter and observing the type of response. This varies with the quantity injected, the injection pressure, the position of the catheter in the ureter and the physiological state of the ureter. If the catheter is in the lower part of the ureter the excursions of the lever produced by the contractions are larger than if it is higher up. If the tone of the ureter is good the injected fluid is expelled quickly by frequent and powerful contractions which are

recorded by large excursions of the lever. Where the tone of the ureter is poor no response may be elicited or only very slight and delayed. If the condition is one of spasm the lever is maintained at a constantly high level with few very slight excursions.

Trattner, in the same article, affirms that the pressure of bimanual renal compression or increased intra-abdominal pressure is not transmitted to the recording lever through a normal or hypertonic ureter. In the case of a dilated and atonic ureter, on the other hand, the lever rises when the intra-abdominal pressure is increased. Normally the tone of the ureter varies at various points in its course: many observers have found that the lower half of the ureter supports a very much higher column of fluid than the upper half. This probably has some bearing on the dilatation affecting the upper part of the ureter during pregnancy.

It is important to have an accurate method of estimating tone as although in many cases stasis of urine is due to mechanical obstruction, it may also be due to disturbance of the normal conductive power of the kidney

pelvis and ureter. Further, the renal secretion may be influenced by alterations in the tone of the upper urinary tract. **Mackersie** (1924) from his experiments concludes that the anti-diuretic action of pituitrin is due to spasm of the ureters. In many cases of hypotone and hypertone the pyelogram appears normal and there is no obstruction to the passage of a catheter, so that only the information obtained by the hydrophoragraph reveals the true nature of the disturbance of function. I have devised a simple apparatus for the estimation of ureteral tone in pregnancy, on the same lines as the hydrophoragraph. It is described in Chapter III.

(4) Reaction to Drugs. According to **Jona** (1931), **Herbst** (1931), **Gruber** (1930²), pituitrin causes contraction of the kidney pelvis and ureter and, according to **Gruber**, the lower third is much more affected than the rest. These authors state that eserine causes a similar contraction of pelvis and ureter. Adrenalin causes contraction of the kidney pelvis long after the blood pressure has reached its maximum. **Herbst** states that morphia also stimulates

ureteral contractions. Atropine causes a relaxation. Histamine causes a fall in blood pressure and a relaxation of the kidney pelvis, according to Koessler and Hanke (1919). They suggest that histamine is produced by B. coli communis on histadine, which is found in the bowel, and that this explains the condition of relaxation found in infection of the urinary tract. Histamine in dilute solution increases the rate and force of ureteral contractions, according to Gruber (1930²). Jona found that sodium citrate appears to cause a sustained contraction of the kidney pelvis with increase in the amplitude of the peristaltic waves. Change of the hydrogen-ion concentration value from 7.8 to 5.6 had no effect on the contractions.

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CHAPTER II.

THE UPPER URINARY TRACT IN GYNAECOLOGICAL CONDITIONS.

I. The diagnosis of lower abdominal pain.

II. The effect of gynaecological tumours on the upper urinary tract.

(1) Pelvic cellulitis.

(2) Ovarian cyst.

(3) Fibromyoma.

III. Discussion.

Bibliography.

This investigation of the urinary tract in gynaecological conditions has been undertaken to compare the effect of the gravid uterus on the urinary tract in pregnant women with that of gynaecological tumours of similar size on the urinary tract in the non-pregnant, and to ascertain whether the urinary tract might be responsible for unexplained lower abdominal pain frequently found in gynaecological cases.

I. THE DIAGNOSIS OF LOWER ABDOMINAL PAIN.

The following observations are based on the results of urological investigation of 32 gynaecological cases, where the complaint was abdominal pain but no palpable lesion could be made out in the pelvis to account for it. Ten had a recognisable abnormality of the urinary tract, namely hydronephrosis in 3, ptosis of the kidney in 2, marked atony of the ureters especially before menstruation in 1 and pyelitis in 4. In one of the cases of pyelitis the pain had persisted since the birth of the second child $2\frac{1}{2}$ years previously, when the patient had had puerperal sepsis, with a large mass in the pelvis. On

admission to the gynaecological ward 2½ years postpartum, vaginal examination revealed thickened and tender adnexa, but not enough to account for the symptoms which consisted of rigors, high temperature and lower abdominal and renal pain. The urine was loaded with pus and coliform bacilli. She had had several similar attacks since the delivery. The acute symptoms settled within a week and 10 days after admission urological examination showed that the urine from both kidneys was sterile, and only a few coliform organisms were present in the urine from the bladder. On X-Ray examination slight clubbing of the calyces on the right side was found. The acute symptoms were undoubtedly due to the urinary infection, which however cleared up quickly as elimination was very efficient. It is possible that reinfection occurred on each occasion from the chronically infected reproductive organs. According to Winsbury White (1933), chronic cervicitis is a frequent source of urinary infection. He showed that particles of dye injected into the cervix were absorbed by the lymphatics and carried to the ureter. Further, he states that many cases of chronic urinary infection can only be cleared up after the cervicitis has been treated.

In the remaining 22 of the 32 cases with unexplained abdominal pain, 68 per cent., no obvious abnormality of the urinary tract could be detected. In many cases, however, pain produced in filling the upper urinary tract for a retrograde pyelogram was exactly similar to the pain complained of, suggesting that the latter was of renal origin. If the pain is right-sided very often the patient has had appendicectomy without benefit. According to Guy Hunner (1925), such pain is very frequently due to a ureteral stricture, and will disappear on dilatation of the stricture. Very few urologists, however, agree with Hunner's views as to the frequency of ureteral stricture. In my experience large catheters can be passed up to the kidney pelvis in those cases without difficulty. It appears to me much more probable that the pain is due to irregular ureteral activity causing spasm. Saitz (1931) goes so far as to state that the pain of dysmenorrhea is due to spasm at the lower ends of the ureters and claims to relieve the pain by inserting a ureteral catheter. When the catheter is removed the pain returns. Although one would not go so far as Saitz as to claim that the ureteral spasm is the

whole explanation of dysmenorrhea, it seems highly probable that there may be spasm of the ureter associated with the spastic condition of the uterus, which is commonly held to be present in cases of dysmenorrhea.

From observations by chromocystoscopy in those 22 cases, without obvious abnormality of the urinary tract, I am convinced that alterations in the tone of the ureters occur at various stages of the menstrual cycle and more exact knowledge of these changes will lead to better understanding of the factors controlling ureteral activity and the true nature of the pain in those unexplained cases.

II. THE EFFECT OF GYNAECOLOGICAL TUMOURS ON THE UPPER URINARY TRACT.

It is common knowledge that gynaecological tumours, both inflammatory and neoplastic, are frequently associated with urinary symptoms, usually disturbances of micturition due to displacement of or pressure on the bladder, but it is not generally recognised that dilatation of the upper urinary tract may also occur in these cases. In cases of advanced carcinoma of the cervix, however, it

is well known that the ureters may be compressed in the parametrium or at the pelvic brim by the carcinomatous tissue and complete suppression of urine, owing to blockage of both ureters, is one of the recognised causes of death.

(1) Pelvic cellulitis. Of 11 cases of pelvic cellulitis, in which a urological examination was done, there was no delay in excretion in 3, which were cases of salpingo-oophoritis with very slight cellulitis. In the remaining 8 cases cellulitis was extensive and there was delay in excretion, more marked on the left side in 5 and on the right side in 3.

A typical example of this type is the case of Mrs. P., who had a large mass filling the pelvis and palpable abdominally. From the retrograde pyelogram in Fig.1, the left urinary tract is seen to be dilated uniformly down to the brim of the pelvis. There is slight kinking of the ureter below the kidney pelvis but no lateral displacement of the ureter. The right ureter was similarly affected but to a less degree. As the acute oedema subsided, the dilatation of the urinary tract also diminished.

In cases of acute and subacute pelvic cellulitis partial obstruction of the lower end of the ureter occurs and results in dilatation and stasis in the ureter above this point, which disappears with the subsidence of the

oedema. Where the cellulitis becomes chronic, however, the intramural and juxtavesical portions of the ureter may become permanently deformed, with impairment of the ureterovesical sphincter. Hurst (1930) is of the opinion that cellulitis may result in degenerative changes in the nerve plexuses in the intramural portion of the ureter leading to lack of relaxation of the sphincter (achalasia) and so to dilatation and stasis in the ureter. Pelvic cellulitis may also adversely affect the ureter by preventing the involution of the hypertrophic changes which occur in the lower end of the ureter in pregnancy to be described later.

(2) Ovarian cyst. Only one of the 11 cases of ovarian cyst had no delay in excretion, an XI-para with a moderately sized soft cyst which floated about freely in the abdomen. Where the cyst is adherent to the tissues in the neighbourhood of the pelvic brim dilatation and stasis are always found. The most marked example of this was a malignant ovarian cyst of moderate size adherent to the pelvic brim at the left side.

An intravenous pyelogram in this case failed to give any shadow of the left kidney pelvis or ureter in 50 minutes. The retrograde pyelogram (Fig.2) shows marked dilatation of the calyces, kidney pelvis and ureter, stopping abruptly at the pelvic brim. The urea concentration was very much lowered on the left side, confirming the diagnosis of gross impairment of renal function deduced from the result of intravenous pyelography.

Simple cysts which are not adherent may cause dilatation and stasis in the upper urinary tract, as the following cases illustrate.

Miss McK. had a simple broad ligament cyst growing from the left side. An intravenous pyelogram (Fig.3) shows kinking and displacement of the ureter, resembling the condition commonly seen in pregnancy. She had amenorrhea for some months.

As the cyst in this case was not very big, it is possible that a disorder of the endocrine balance lowered the tone of the ureteral musculature, so that it was more susceptible to pressure. As will be seen later, this is probably what occurs during pregnancy.

Miss J. had a very large cyst filling the whole abdomen and causing marked distension of the abdominal wall. Laparotomy showed that the cyst was lying mostly on the right side, compressing the right ureter against the psoas muscle. The left ureter almost escaped except where it crossed the pelvic brim. The intravenous pyelogram (Fig.4) taken 45 minutes after injection of uroselectan shows marked dilatation of the right kidney pelvis and

calyces but ureter not yet showing. On the left side the renal tract is normal except for slight lateral displacement. In the plate taken one hour after injection (Fig.5), the right ureter is now shown dilated and kinked, but not displaced laterally. However, the fact that it cannot be demonstrated for some distance above the pelvic brim indicates that in this area it is compressed by the cyst against the psoas muscle.

In the cases where the cyst fills the pelvis and reaches to the level of the umbilicus (i.e. approximately the size of a 5 months' pregnancy), the ureter on the side most affected by the cyst can be demonstrated clearly by intravenous pyelography down to the pelvic brim, for example as in the case of Mrs. McK. (Fig.3), showing that the point of compression is at the pelvic brim. Where the cyst is so large as to fill the abdomen completely up to the costal margin, as in the case of Miss J. (Fig.4), the compression is not at a single point but the ureter is flattened against the psoas muscle for some distance above the pelvic brim. The same thing is found during pregnancy. In the fifth month the ureters are dilated and show clearly down to the level of the pelvic brim. Near full time one of two things will have happened; either compression of the ureter for some distance above the pelvic brim, as seen in the pyelogram in Fig.55, or

lateral displacement of the ureter so that it escapes the compression against the psoas muscle and is only compressed at the point where it crosses the pelvic brim (see Fig. 65). The reason for the different positions taken up by the ureter will be discussed in detail in Chapter III. The significant resemblance between the effects on the ureter by the presence of an ovarian cyst and of a pregnant uterus points clearly to mechanical pressure being an important factor in the production of the changes occurring in the urinary tract in pregnancy. Lee and Mengert (1934) argue that the dilatation caused by pregnancy disappears too quickly in the puerperium for the cause to be mechanical pressure, and conclude that a disturbance of hormones peculiar to pregnancy is the important factor. While I agree that alteration in endocrine balance plays an important part in the production of the changes in the urinary tract in pregnancy, their argument does not rule out mechanical pressure as an important factor also, for I have found in cases of ovarian cyst, where the mechanical pressure is the only factor, that the dilatation of the urinary tract disappears very quickly after removal of the cyst. In the case of Miss J., 10 days after operation,

the indigocarmine excretion time was normal and a retrograde pyelogram (Fig.6) shows that the urinary tract has completely returned to normal. Further, after pregnancy the disappearance of the dilatation is often delayed, and the finding of Lee and Mengert to the contrary is due to their reliance on intravenous pyelography to demonstrate the contour of the urinary tract. While this method is admirable during pregnancy, the lack of obstruction to out-flow makes it quite unreliable in the puerperium, when recourse to retrograde pyelography is necessary. This point is discussed in Chapter III and clearly illustrated by means of pyelograms in Figs. 40, 41 and 42.

Where the cyst presses equally on both ureters, the right is more affected than the left, due to its more exposed course as explained on page 8. This is probably an important factor in the preponderance of dilatation of the right urinary tract in pregnancy.

Miss W. had a large ovarian cyst which on laparotomy was found to fill the abdomen uniformly and, as far as could be judged, it pressed equally on both urinary tracts. The intravenous pyelogram in Fig.7 shows that the right urinary tract is dilated down to the level of the pelvic brim but there is no displacement of the right ureter. The left urinary tract is practically normal.

This case clearly shows that with equal pressure at the pelvic brim, the right urinary tract is more affected than the left.

The following case also demonstrates this point and proves that the pressure is greater on the right side, for although there is dilatation of the left ureter, the calyces on the left side have escaped, while on the right the calyces are more affected and there is impairment of renal function.

Miss H. had an ovarian cyst which reached to a little above the umbilicus and pressed equally on both urinary tracts as far as could be ascertained. The pyelogram in Fig.8 shows that both tracts are dilated to the pelvic brim but the right much more than the left. The indigo carmine test showed that the function on the left side was normal while on the right although the ureteral function was normal, renal function was impaired. This agrees with the appearances seen in the pyelogram where, although both ureters are dilated to much the same extent, the calyces of the right kidney are much more dilated than these of the left.

As will be seen later, this distribution of the dilatation corresponds exactly to what is found in pregnancy.

The ureteral function may be upset by even very small cysts, as the following case illustrates.

Miss C. had a history of acute attacks of left-sided abdominal pain of several weeks' duration, with frequency of micturition. Chromocystoscopy showed that there was no delay in excretion of indigocarmine at the right side and at the left, although no dye appeared in 12 minutes the ureteral orifice was seen to be pulled up at frequent intervals, indicating obstruction to outflow in an active ureter. A catheter passed to a point above the pelvic brim immediately drained off urine deeply stained with indigocarmine, showing that the renal function was unimpaired, and this was followed by instantaneous relief of the pain. The catheter pyelogram (Fig.9) shows a narrowing of the ureter at the level of the brim of the pelvis, with dilatation above. At laparotomy the cyst was found to be growing from the right ovary, twisted on its pedicle and lying on the pelvic brim on the left side. There was no pressure on the right ureter. The pain was not due to twisting of the pedicle but to spasm of the ureter set up by the pressure of the cyst.

(3) Fibromyoma. It has been possible to perform urological examination in only 2 cases of fibromyoma big enough to be comparable as regards size with the pregnant uterus in the second half of pregnancy. In neither case was there any delay in excretion and at laparotomy it was seen that there was no direct pressure on the ureters, owing to the firm consistency of the tumour preventing it fitting closely into the irregularities of the pelvic brim. Middleton (1929), however, found that fibroids if present for a long time may cause dilatation of the ureters. In a case of a left-sided cervical fibromyoma (Fig.10) a dilatation of the left urinary tract was seen right down

to the bladder, showing that the pelvic portion of the ureter does dilate if the obstruction is sufficiently low, but even then it is not so much dilated as the middle third, showing that its wall is not so liable to distension. This picture of the ureter, showing throughout its whole length, where the obstruction is known to be in the juxta-vesical portion, is in marked contrast to the appearances in pregnancy where the shadow of the ureter is always interrupted in the neighbourhood of the pelvic brim. This is an additional piece of evidence of the obstruction in pregnancy occurring at the pelvic brim.

Of the 25 cases of pelvic cellulitis, ovarian cyst and fibromyoma, there was only one with infected urine. The patient complained of right-sided pain which was unrelieved by the removal of a cyst about 6 inches in diameter, growing from the right ovary. X-Ray examination showed a large branching calculus, filling the calyces and kidney pelvis on the right side. The urine from the right kidney was infected. She had had the symptoms for 3 years and it is impossible to say whether the cyst had anything to do with the formation of the calculus and the occurrence of the infection or not.

III. DISCUSSION.

A search of the literature reveals very few references to the effect on the urinary tract of gynaecological tumours and those which do exist express the view that such tumours cause little or no dilatation of the urinary tract. Brakemann (1930) states that tumours reaching to the umbilicus give rise to very slight dilatation of the ureters. Schmidt (1928) says that in spite of large tumours there is no delay in excretion. Stein and Rodgers (1932) state that neither ovarian cysts nor fibroids can give rise to dilatation, a finding confirmed by Strumpf (1933), who also includes pelvic cellulitis. All these workers base their conclusions on very small numbers and insufficient data as to the position, size and consistency of the tumour. On the other hand, from my survey of 25 cases of pelvic cellulitis, ovarian cyst and fibromyoma, I have demonstrated conclusively that tumours of sufficient size and soft consistency can compress the ureter and cause dilatation and interference with kidney function. If the cyst is situated to one side, it causes dilatation of the urinary tract on the same side and less or no dilatation on the other side.

Where the cyst fills the abdomen uniformly and appears to exert pressure equally on both sides, the right urinary tract is dilated more than the left. This confirms the view that the right urinary tract is more exposed to pressure than the left. As a rule the dilatation produced in these cases is less than that produced in a pregnancy of corresponding size, and the consequent stasis is very markedly less as the tone of the ureter, as judged by the vigour of the efflux, is not impaired in the non-pregnant state to the same extent as in the pregnant. It has been said in support of the statement, that ovarian cysts do not cause dilatation of the urinary tract, that pyelitis is never seen in these cases, but as the incidence of clinical pyelitis, even in pregnancy, is only 1 per cent., much larger numbers would have to be studied before definite conclusions could be reached on this point. Moreover, as has been pointed out above, the stasis in the non-pregnant cases is never so great as in the pregnant, so that the liability to infection cannot be so great. In some cases an ovarian cyst may cause spasm of the ureter, giving rise to pain. In some cases of unexplained abdominal pain without any gynaecological lesion, the underlying condition

may be spasm of the urinary tract, due to disordered function, probably hypertonus. In these cases the pain elicited by the passage of a ureteral catheter or the injection of sodium iodide into the ureter is exactly similar to the pain complained of. In other cases infection or gross abnormality of the urinary tract is the cause of the unexplained pain.

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CHAPTER III.

CHANGES IN THE UPPER URINARY TRACT IN PREGNANCY AND THE PUERPERIUM.

I. Investigation of post-mortem material.

- (a) Naked-eye appearances.
- (b) Microscopic appearances.
- (c) Discussion.

II. Investigation in the living subject.

Methods.

- (a) Cystoscopy and chromocystoscopy.
- (b) Ureteral catheterisation and separate kidney function tests.
- (c) Pyelography.
- (d) Graphic representation of ureteral function.

Results.

- (1) of chromocystoscopy, intravenous pyelography, ureteral catheterisation and separate kidney function tests.
- (2) of experimental work on the tone of the ureter.

Clinical Aspect.

Summary and Discussion.

Bibliography.

It has been long recognised that dilatation and stasis of the upper urinary tract occur frequently in pregnancy, but although much information about the nature of the change has been gained recently through the development of urological methods, its significance and cause are not yet fully understood. One of the earliest workers on the subjects was Opitz (1905), who came to the conclusion from the examination of post-mortem material that the condition was due to compression of the ureter, especially the right, between the uterus and the structures at the pelvic brim. The work of Carson (1927) and others supports this view. The observation that the dilatation in some cases extends throughout the whole length of the ureter led Stoeckel (1925) and others to believe that it was due to a general atony of the urinary tract. Hofbauer (1928) found a definite hyperplasia of the wall and sheath of the ureter at its lower end and believes that this constitutes an obstruction to outflow at the bladder, causing the dilatation of the ureter throughout its whole length. More recently by the application of urological methods much interesting work has been done, especially in Germany, on the relationship of this anatomical change to disorders of

function. Gremme (1931), comparing the views of the various workers, comes to the conclusion that there is atony of the upper urinary tract in pregnancy which makes it possible for the ureter, especially the right, to be compressed between the uterus and the psoas muscle, that dilatation of the urinary tract does not necessarily mean the presence of stasis, and that there may be delay in emptying the upper urinary tract without the kidney function being affected. The problems we are confronted with are:- the cause of the primary atony which appears to be an important factor in the production of the dilatation; what effect these changes which occur in pregnancy have on the function of the ureter and kidney; what bearing they have on the occurrence of infection, with particular reference to pyelitis of pregnancy; the involution of these changes in the puerperium and their relationship to the occurrence of urinary infection in the puerperium.

Towards their solution I have correlated the results obtained by post-mortem, clinical, urological and bacteriological examination.

I. INVESTIGATION OF POST-MORTEM MATERIAL.

The ureters and kidneys of 102 women dying during pregnancy or within a few days of delivery have been examined. In certain cases before dissection the bladder was opened and a ureteral catheter inserted through the ureteral orifice. The upper urinary tract was then filled with water until slight pressure was necessary to empty the syringe. This gave the capacity of the kidney and ureter. It also allowed an accurate study of the dilated portions of the ureter in relationship to the bony pelvis and to the uterus.

The urinary tracts were then dissected out, again filled with fluid, measurements taken and in certain cases pieces removed for histological examination. Control material was examined from non-pregnant women. In many of the cases, as many as four pieces were removed from each ureter for histological examination — a piece from the intravesical portion, one from the juxtavesical portion 3 cms. from the bladder, one from the widest part above the pelvic brim and one from the junction with the renal pelvis. While this method is of little value in detecting minor

degrees of dilatation of the ureters, it allows a careful study in cases where there is gross dilatation. It also enables one to make a histological examination to decide whether any changes occur in the wall of the ureter as a result of pregnancy.

(a) Naked-eye appearances.

To begin with, the cases were analysed in two groups according to whether they died within 3 days of delivery or later in the puerperium, but this was discarded and the cases all grouped together as it was found that it made no difference to the results. 18 of the cases were less than 7 months' pregnant and were not included in the first analysis.

TABLE I.

Dilatation.	Primigravidae (32).		Multiparae (52).	
	Right.	Left.	Right.	Left.
None.	2	5	10	18
+ - -	2	7	4	13
+ -	6	7	24	12
+	12	10	7	6
+ +	8	1	5	2
+ + +	1	2	2	1
+ + + +	1	0	0	0
	$\left. \begin{array}{l} 8 \\ 1 \end{array} \right\} 69\%$		$\left. \begin{array}{l} 5 \\ 2 \end{array} \right\} 25.7\%$	
	$\left. \begin{array}{l} 10 \\ 1 \\ 2 \end{array} \right\} 40.6\%$		$\left. \begin{array}{l} 6 \\ 2 \\ 1 \end{array} \right\} 17.3\%$	

Dilatation of + indicates a urinary tract with a total capacity kidney and ureter of 20-30 ccs.; + + 30-50 ccs.; + + + 50-70 ccs., and + + + + over 70 ccs. One + therefore represents a fairly marked dilatation.

Table I is an analysis of the remaining 84 cases and shows that there is dilatation of the right urinary tract in 85 per cent. of cases, and of the left in 72 per cent. Dilatation, as is generally recognised, is more marked on the right side but, contrary to what has often been stated, is more marked in primigravidae than in multiparae. The right ureter shows a + dilatation

or more in 69 per cent. of the primigravidae and in only 25 per cent. of the multiparae. On the left side there is a + dilatation in 40 per cent. of primigravidae and in 17 per cent. of multiparae. The same rule was found on analysis of the cases where the pregnancy had lasted less than 30 weeks. Of the 9 primigravidae, 33 per cent. showed a + dilatation on the right side and 11 per cent. on the left. Of the 7 multiparae, 22 per cent. had a + dilatation on the right side and 11 per cent. on the left. In 5 cases the left ureter was more dilated than the right.

In 48 cases the distortion of the urinary tracts was of the type which I consider to be characteristic of pregnancy. It is asymmetrical. On the right side the ureter is dilated from the pelvic brim upwards and is markedly elongated and kinked. The kinks vary in number and distribution, but the most common sites are immediately below the kidney pelvis and the junction of the upper and middle thirds.

The dilatation also affects the kidney pelvis and calyces and the right kidney is often much larger than the left as a result. Below the pelvic brim there is often no dilatation of the ureter or, if present, it is seldom

marked, so that at this level an abrupt narrowing of the lumen usually occurs. There may sometimes be an acute kink at this point. On the left side some dilatation also occurs but the kidney pelvis and calyces frequently escape. There is a dilatation of the ureter, however, which is widest at or slightly above the pelvic brim and does not narrow suddenly below the brim but tapers gradually to the bladder, so that very often the left ureter may actually be broader than the right immediately below the pelvic brim.

Fig.11 (Priest) shows the urinary tracts of a III-para who died 9 days after delivery. The right urinary tract is dilated and kinked to the level of the pelvic brim, whereas on the left side the ureter alone is dilated in the middle third and upper part of the lower third.

Fig.12 is a diagrammatic representation of those changes in a primi-para, who died of obstetric shock a few hours after delivery. It was made graphically from exact measurements. Each ureter held 6 ccs. but the kidney pelvis and ureter on the right side held 25 ccs., while on the left they held 15 ccs., so that the capacity of the right kidney is more than twice that of the left. Just below the pelvic brim the left ureter is slightly wider than the right.

The following photographs illustrate the variety of appearance which is found in the urinary tracts of these cases.

Fig.13 shows that although both kidney pelves are markedly dilated the ureters are only slightly affected, on the right side from the pelvic brim upwards and on the left uniformly from a few centimetres above the bladder. Just below the pelvic brim the left ureter is wider than the right.

Fig.14 shows the same distribution of the deformity but very little dilatation of the kidney pelves.

Fig.15 shows the urinary tracts of a primipara who died one month after delivery. There is very little dilatation of the kidney pelves but both ureters are dilated. On the right side the upper half of the ureter is more dilated than the lower half, while on the left side the reverse is seen, and there is no abrupt narrowing at the pelvic brim.

Fig.16 shows the urinary tracts of a primipara who died one week after delivery, of pyelitis. The left ureter is more dilated in its lower half and the right is slightly more dilated above the pelvic brim than below it.

Occasionally the dilatation of the left urinary tract also is marked, in which case the deformity on the

left side resembles that typical of the right. As a general rule where the dilatation was marked on the right side, it was pronounced also on the left to a less degree, but occasionally where the right urinary tract was enormously dilated the left showed only very slight dilatation.

Fig.17 shows the urinary tracts of a primipara who died within 24 hours of delivery. On the right side typical dilatation and kinking of the ureter is seen above the pelvic brim. On the left side the same deformity from the pelvic brim upwards is seen to a lesser degree.

Fig.18 shows the ureters grossly dilated from the pelvic brim upwards on both sides.

Fig.19 shows that enormous dilatation and kinking of the right urinary tract can be present with very little of the left. The right kidney is much bigger than the left, indicating that the dilatation affects the calyces. There is, however, no demonstrable histological difference between the two kidneys but, as will be seen later, function of the kidney in such cases is greatly disturbed.

Fig.20 shows the kidneys in a typical primigravida opened to show the dilated kidney pelvis and calyces on the right

side with increase in the size of the kidney.

These observations point to the existence of an obstruction in the right ureter at the level of the pelvic brim as it is consistently dilated and kinked above this point. In some cases similar obstruction, though less marked, appears to occur in the left ureter, but as a rule when it is dilated the dilatation affects the whole ureter and there does not appear to be any special point of compression, as the normal contour is preserved, the most dilated part being the middle third, which is normally the widest part. As I shall show later, the ureters in the early months of pregnancy undergo a slight general dilatation as a result of the pregnant state. The right ureter in the second half of pregnancy becomes obstructed by the pressure of the pregnant uterus on it and becomes further dilated and kinked above the point of compression, and narrowed below it. This corresponds exactly to the deformities produced by experimental compression of the ureter (Smith and Ockerblad, see page 20). The left ureter as a rule appears to escape compression by the pregnant uterus, and the initial dilatation of the early months may persist unaltered to the end of pregnancy.

It is difficult to place the ureters for

photography in the position which they occupy in the body, as the kinks lie in different planes. The kinks remain after the ureter has been removed from the body and if obliterated by firm traction, return immediately it is released. When put on the stretch, bands of fibrous tissue are seen binding the loops together, as is clearly seen in Fig.19. In order to determine whether the kinks cause narrowing of the lumen, the ureters were split open longitudinally in some cases and in others serial sagittal sections were made. Fig.21 is a photograph of the kinked area in a ureter split open longitudinally. It shows that the lumen is narrowed at the apex of the kink. This is supported by the evidence obtained from serial sections. Fig.22 shows the ureters in a primipara who died 48 hours after delivery. The right ureter is acutely kinked and Fig.23 is a photograph of a sagittal section through one of the kinks. It was the section in the series in which the lumen was widest but, nevertheless, definite narrowing is present. Although there can be little obstruction to out-flow as the lumen is still fairly wide, the normal peristalsis may be upset and spasm occur, which will then cause blockage. It will be shown in the clinical study that the distribution of pain arising from the urinary tract

is related to the situation of the kinks. Where there is acute infection of the urinary tract, pus collects in the bends of the kinks and may cause intermittent blockage. The kinks usually disappear very completely after delivery where the pregnancy has been normal, but where pyelitis of pregnancy has occurred, the resultant fibrosis and adhesions may lead to persistence of the kinks.

The cause of death did not appear to bear any relationship to the amount of dilatation present, except in cases of toxæmia where it was consistently very slight. There were 14 multiparae who died of toxæmia, including eclampsia, albuminuria and ante-partum hæmorrhage. None of these showed a + dilatation, most showing very little at all. For the rest of the multiparae in this series the incidence of + dilatation was 40 per cent. This corresponds with the urological findings, that there is a relative absence of delay in excretion in the toxæmic cases. Anselmino, Hoffmann and Kennedy (1932) have shown that, in the toxic albuminuria of pregnancy and eclampsia there is an overproduction of the hormones of the posterior pituitary gland. It is probable that this is the factor which prevents the more marked degrees of atony and dilatation of the urinary tract in these cases.

(b) Microscopic appearances.

The striking microscopic feature in the ureter during pregnancy, as was first demonstrated by Hofbauer (1928), is the excessive hypertrophy of the ureteral sheath. This in the non-pregnant state is a very thin structure, as is seen in Fig.24 which shows a transverse section of the ureter, just where it enters the bladder in a nullipara, aged 18. The sheath here is very uneven in its distribution round the ureter and at one point is almost non-existent.

Fig.25 is a similar section in a nullipara of 38 years and again shows how thin a structure the sheath is. In pregnancy the sheath is enormously hypertrophied, as is seen in Fig.26, which is a section of the right ureter where it enters the bladder in a primipara, who died on the fourth day post-partum. It shows the remarkable development of the ureteral sheath which completely encircles the ureter. The wall of the ureter itself is also greatly thickened.

Fig.27 is a section of the same ureter just below the crossing of the uterine artery and it shows that these hypertrophic changes in the wall and sheath of the ureter

are present at this level also. They are not constantly found in the upper half of the ureter, however, where there is no sheath.

In both the sheath and the wall of the ureter, the increase in thickness is due largely to hypertrophy of the individual muscle bundles and there is also proliferation of the fibrous tissue between them. According to Hofbauer, these hypertrophic changes are analogous to the changes occurring in the lower uterine segment during pregnancy, and are governed by the same factors. I have found that the amount of hypertrophy present varied greatly in different cases and could not be demonstrated in women dying in the early months of pregnancy. The hypertrophy is as common and as marked in primigravidae as in multiparae. The thickened ureters can sometimes be palpated on vaginal examination, as was pointed out as early as 1892 by Saenger. Both ureters are affected, usually to an equal degree, and no relationship could be found between the degree of hyperplasia and the degree of dilatation present. Hofbauer believes that this hypertrophy causes a narrowing of the lumen of the ureter and is thus an obstruction to outflow of urine. In support of this theory he states that in

some cases the dilatation does not stop short at the pelvic brim but extends right down almost to the bladder, pointing to the site of obstruction being at the lower end of the ureter. He believes that the torsion of the pregnant uterus to the right, which commonly occurs, causes kinking of the lower end of the right ureter while the left is merely stretched so that the right ureter becomes more dilated as a rule. I cannot subscribe to this opinion, for the following reasons:- (1) the hypertrophy cannot be demonstrated before the fifth or sixth months of pregnancy, when dilatation of the ureters is often marked; (2) the amount of hypertrophy bears no relationship to the amount of dilatation; (3) contrary to Hofbauer's statement that the right ureter is dilated down to the bladder and that the point of obstruction is the kink of the lower end of the ureter caused by torsion of the uterus, I have found that the right ureter is dilated only as far down as the level of the pelvic brim which must be the point of obstruction; (4) ureteral catheters passed during pregnancy seldom meet with any obstruction at the lower end of the ureter but a certain amount of obstruction is always encountered after the catheter has been inserted 12 to 15 cms. — that is,

to the level of the pelvic brim, and (5) in my experience dilatation of the lower half of the ureter is more commonly seen on the left side than on the right, although according to Hofbauer's theory no obstruction to outflow should exist at the lower end of the left ureter.

The hypertrophic changes are probably in the nature of a protective mechanism to prevent undue compression of the lumen of the lower ends of the ureters in the later weeks of pregnancy, as has been put forward by Duncan and Seng (1928)

In chronic intermittent obstruction in non-pregnant women, the wall of the ureter above the point of obstruction hypertrophies in the first instance and only if the obstruction is progressive does the ureteral wall become thinned out and stretched. Figs. 28 and 29 are sections of the right ureter in a pregnant woman from the pelvic portion and from the widest part above the pelvic brim. We see that in the dilated part of the ureter the wall is thinned out and no appreciable hypertrophy or hyperplasia of fibres could be made out. This suggests that the contractile power of the ureter has been lessened.

Figs. 30 and 31 are transverse sections of the ureters of

a pregnant woman in the last month. The sections are taken one from each ureter at the same level, several centimetres above the pelvic brim. The right ureter, Fig.30, was dilated much more than the left, Fig.31, and its wall appears to be stretched and thinned out. Under higher magnification, stretching of the existing muscle fibres can be made out. A comparison of Figs. 32 and 33, which are small portions of the wall in the right and left ureters respectively, shows this clearly. In Fig.32 the submucosa is oedematous and the longitudinal muscle bundles are flattened out. The circular bundles are also diminished in size. These histological appearances suggest stretching of an atonic structure, rather than the breakdown of a compensatory hypertrophy. The difference on the two sides corresponds to the fact, to be demonstrated later, that the dilated right ureter is usually much more atonic than the less dilated left ureter.

(c) Discussion.

A careful examination in women who have died undelivered or in the living before performing Caesarean Section shows that the ureter can be compressed between the

uterus and the psoas muscle on the right side. Fig.34 is a sketch of the urinary tracts in situ of a primipara who died a few hours after Caesarean Section for contracted pelvis. It shows enormous dilatation and kinking of the right urinary tract down to the point where it crosses the common iliac artery. Stretching across the kinks light bands of fibrous tissue are seen. In its upper portion the right ureter is displaced laterally beyond the outer border of the psoas muscle and where it bends medially to cross the belly of the psoas muscle it was flattened by the uterus and empty of urine, whereas the portion above that was distended with urine. The left ureter is displaced laterally and slightly dilated in its middle third; it narrows quickly as it crosses the common iliac artery to descend into the pelvis behind the sigmoid colon. The left kidney pelvis is undilated.

In some cases the compression seems to be between the uterus and the common iliac artery which on the right side, as it has to cross the vertebral column, lies more anteriorly than on the left and pushes the ureter forward. At Caesarean Section flexion of the thigh to relax the psoas muscle relieves the compression of the ureter to some extent.

This may explain the partial relief of pain experienced by some pregnant women on flexing the thigh. On the left side the ureter is less exposed to pressure for several reasons. In the first place, because of the difference in the course of the common iliac vessels on the two sides, it lies more posteriorly on the left and, instead of crossing the vessels almost at right angles as on the right side, it runs almost parallel to them. It is therefore partly protected from pressure at the pelvic brim by the promontory of the sacrum. Secondly, the left ureter at the pelvic brim passes behind the sigmoid colon and its mesentery. The peristalsis of the bowel makes any pressure on the left ureter intermittent and may directly stimulate ureteral peristalsis. The torsion of the uterus to the right does not really enter the question at all, as it is not displaced laterally, and any effect produced by kinking the lower end of the right ureter must be negligible, as the pelvic portion of the right ureter does not appear to be obstructed. I have observed at Caesarean Section that the uterus is sometimes twisted to the left and that in these patients the dilatation is not more marked on the left side. In the non-pregnant state, ovarian cysts have been shown to cause dilatation of the

ureters. As the cyst is usually situated to one side it causes dilatation of the ureter of the same side. If the cyst is so large as to cause uniform pressure in all directions the right ureter is always more dilated than the left, as has been shown on page 47. The right ureter is therefore more exposed to pressure than the left in both the non-pregnant and pregnant states. This is due in all probability to the different course of the two ureters as they cross the pelvic brim and not to the uterus twisting to the right. This is further supported by the fact that all the cases of scolio-rachitic pelvis with displacement of the sacrum to the left, so that the course of the right ureter is still more exposed, have shown very marked dilatation of the right urinary tract. The same is true to a less marked degree of cases of flat rachitic pelvis. Fig.35 is an intravenous pyelogram in a case of scolio-rachitic pelvis and it shows the enormous dilatation of the right kidney pelvis and upper third of the ureter. Many authors have observed the dilatation of the urinary tracts at autopsy in women who died during pregnancy or in the early stages of the puerperium, but I have been unable to find a detailed description of the exact changes, both macroscopic and

microscopic, such as I have given above, nor any satisfactory explanation of the difference between the two sides.

II. INVESTIGATION IN THE LIVING SUBJECT.

Methods.

(a) Cystoscopy and chromocystoscopy. Cystoscopic examination in pregnant women is usually an easy procedure and causes very little disturbance. The passage of even a large catheterising cystoscope is usually not difficult owing to the laxity of the tissues including the external urinary meatus.

Even in early pregnancy the trigone is raised and the posterior wall of the bladder pushed forward. There is often a marked congestion of the base of the bladder and, to a less extent, of the bladder wall. The ureteral orifices become more widely separated, especially near full time. At this stage the foetal head pushes the posterior bladder wall forward and shortens the anteroposterior diameter of the bladder so much that the cystoscope has to be introduced into one of the lateral pouches which are so formed. The ureteral orifices are usually slightly elongated and in

some cases are directed laterally, at right angles to the urethra, so that they cannot be seen. In multiparae when the bladder is filled the foetal head often recedes or can be easily pushed out by the finger in the vagina, but in primigravidae this may be impossible and cystoscopic examination should not be attempted. For these reasons it has been found easier when cystoscoping pregnant women to have them lying flat on the back instead of half sitting up, as is usual during urological examination.

Cystoscopy is almost painless where a normal examining cystoscope is used and an anaesthetic is never necessary. When a larger instrument is used there is often some discomfort in introducing it even when well lubricated with K.Y. Jelly, but experience makes it possible to pass large catheterising cystoscopes with very little discomfort. In cases where a general anaesthetic is required I have found that 'Evipan', a new intravenous anaesthetic which gives 15 minutes' anaesthesia, is very suitable.

The bladder capacity is well within normal limits as a rule in pregnancy and although pyuria is so frequently encountered, the ease with which the bladder can be washed free of pus suggests that the cystitis is usually secondary

to infection of the upper urinary tract and is slight in degree. This confirms the clinical finding that bladder symptoms are usually slight or absent. In many cases the intramural portion of the ureter is very prominent and the ureteral orifice raised, thickened and indurated. This is what would be expected in view of the thickening in this area demonstrated histologically.

Simple cystoscopic examination has seldom been performed alone but is combined with chromocystoscopy, catheterisation of the ureters, urea concentration in the urine from separate kidneys and, in some cases, with X-Ray examination. My technique for chromocystoscopy is as follows: 5 ccs. of 0.4 per cent. indigo carmine are given intravenously and the time of appearance of the dye at the ureteral orifices noted through the cystoscope. The great advantage of this test is that the results are forthcoming at once, which is very useful in out-patient practice. Where the dye appears in 4 minutes in good concentration, we can conclude that the kidney function is good and that there is no dilatation of the upper urinary tract. During pregnancy there is generally an absence of vigour in the ureteral peristalsis which makes the efflux difficult to

see unless stained by dye. The size of the efflux, the interval between the ejections and their vigour all give valuable information as to the function of the ureter. Lack of concentration of the dye may be due to many causes. Where the efflux is regular and powerful it may be due to deficient kidney function. Where the efflux is irregular in size and time it may be due to dilatation of the upper urinary tract, in which case the efflux soon becomes well concentrated, whereas if the cause is in the kidney the concentration of the dye remains fairly constant. Delay in the appearance of the dye cannot be taken as a sign of kidney damage, especially during pregnancy. For example, it is not uncommon in clinically normal cases, after giving indigo carmine, to wait for about 15 minutes and see no excretion of indigo carmine from the right ureteral orifice. During this time no movement of the ureteral orifice is seen or there may be a few futile contractions of the orifice, that is, the orifice is seen to be drawn up but does not open and no dye is emitted. At the end of this time small puffs of urine well coloured with indigo carmine may begin to appear, followed by increasingly bigger puffs in quick succession until the efflux is very much bigger and more

prolonged than normal. The efflux may become thereafter gradually smaller and the intervals between each longer till they cease altogether. This may be followed again by a period of rest for 10 to 15 minutes before the same cycle is repeated. The indigo carmine excretion time will therefore depend to some extent on the stage of the cycle at which the injection was given. The delay in such a case is due to disordered ureteral function, not to disordered kidney function. Although in the undilated ureter the action is as a rule fairly regular, about six times per minute, it is very often irregular both in time of occurrence and vigour. In some cases there is overaction, the ureter contracting as often as twelve times per minute. As a rule, delayed excretion due to irregular ureteral function indicates dilatation of the ureter and atony of its wall, but dilatation of the ureter may occur with little delay in excretion. Where the delay in the appearance of the dye is due to dilatation and atony of the ureter, massage over the affected side will have a marked effect in stimulating ureteral contractions, unless obstruction to outflow is marked or the ureter is stimulated when it is practically empty. Where there is very marked atony of the ureters,

especially in severe infections, the ureteral orifices may be immobile for long periods at a time. Usually this means that no contractions are occurring at all and no urine is escaping. In other cases the orifice seems to be partly fixed and the urine is escaping continuously, oozing so gently that the efflux cannot be detected even in chromocystoscopy, as the concentration of the dye is so poor. Additional information is obtained by passing ureteral catheters.

(b) Ureteral catheterisation and separate kidney function tests. There is no particular difficulty in introducing a catheter into the ureter during pregnancy, except where the ureteral orifices are displaced laterally. Slight obstruction is usually encountered at the brim of the pelvis and in the upper third of the ureter more or less complete obstruction may be met with, due to very acute kinks.

When a catheter is passed into an undilated ureter, drops come away slowly and intermittently, two or three at a time. Where dilatation of the ureter is marked, drops are continuous or very frequent for a long time,

perhaps half an hour, until the kidney pelvis and ureter are quite empty. With an average size of catheter, no.10 F. the quantity drained through the catheter in 3 minutes is used as a measure of the amount of dilatation present. A dilated urinary tract will drain as much as 10 to 20 ccs. in this time, while an undilated one only 2 ccs.

Where delay in excretion has been diagnosed by chromocystoscopy, the passage of a ureteral catheter will give information as to its cause. If the delay is at or near the ureterovesical junction, the coloured urine is tapped on introducing the catheter past the sphincter. If the delay is at or near the pelvic brim, the dye is tapped after the catheter has been inserted about 15 cms., that is, beyond the level of the pelvic brim. If the catheter is introduced into the kidney pelvis and the urine is still unstained, the delay is in excretion by the kidney.

Fig.36 is a diagrammatic illustration of the use of ureteral catheterisation after injection of indigo carmine. The first diagram shows that the dye has appeared in 5 minutes at the left ureteral orifice but has not appeared in 10 minutes at the right side. In the second diagram catheters have been passed into the lower ends of both

ureters and on the right side only a few drops of clear urine have drained. The catheters are shown in the third diagram to have been inserted further, above the pelvic brim, when immediately urine began to drain quickly from the right side.

As one kidney, usually the right, is very much more affected than the other, separate kidney function tests are necessary to estimate the degree of damage sustained. Tests which require collection of the total output of urine over a fairly long period are difficult to do for several reasons. (1) It is impossible to estimate how much urine escapes past the ureteral catheter into the bladder. (2) On the undilated side, the catheter if left in for any time, especially if it is close-fitting, will give rise to severe discomfort and may have a disturbing influence on the kidney function. (3) On the dilated side if a catheter is inserted above the pelvic brim, the dammed-up urine is drained and the tension on the kidney released. This alters the actual conditions. (4) If the catheter is inserted into the lower half of the ureter, it may be expelled or, after a long interval during which no urine drains away, the upper part of the urinary tract empties and

so much comes away that the catheter cannot take it all. Urine is forced down past the catheter into the bladder, unless it is so wide as to block completely the intravesical portion of the ureter. The use of such a wide catheter is not advisable as it may cause pain and spasm.

In this investigation samples of urine have been taken off from either kidney during the course of a McLean's urea concentration test or in the course of routine examination. By this means the two sides can be compared. As will be pointed out in more detail later, if specimens are taken off from clinically normal pregnant women during the third hour of a McLean's urea test, the urea concentration for the left undilated side may be lower than that for the dilated right side at the same time, whereas an hour previously, that is, at the end of the second hour, the concentration of urea at the left side would be higher than at the right. There is a delay, therefore, in the concentration of urea at the right side and it never quite reaches the concentration of the urea from the left side. The same is found with the indigo carmine excretion test. On the dilated side the excretion of indigo carmine is delayed and the degree of concentration is never so great as on the unaffected side.

Where the dilatation is not enough to cause marked delay in kidney excretion, the dye on the dilated side may be actually better than on the normal side at a certain point of time. Where the pressure on the kidney substance causes much interference with function, the concentration of indigo carmine may never at any point in the excretion reach the level of the better kidney. The rapidity with which the concentration of the indigo carmine improves after the catheter is inserted into the kidney pelvis is a fairly good index of the condition of the kidney.

(c) Pyelography. Intravenous or excretion pyelography has great advantages over the older method of retrograde pyelography. In the first place, artificial distortion of the urinary tract and any risk which may be attached to ureteral catheterisation are avoided. There are few contraindications. I have used it in cases of bilateral pyelitis where the patient's condition was serious without any deleterious results. Braash (1931) says that there are very few contraindications. He has employed it in very feeble patients with a blood urea of 100 mgms. Payne (1932) also finds very few contraindications but stresses the need

for proper preparation of the patient to clear the bowel of gas. Trattner and co-workers (1930) find that catheters may give rise to haematuria and spasm and that sodium iodide has also a very disturbing effect on the urinary tract. It may cause spasm or, in some cases, complete relaxation. Wade (1933) states, however, that intravenous pyelography can never replace retrograde pyelography where very accurate information is required as to the outline of the kidney pelvis as in cases of renal tumour.

The drug I have used is Uroselectan B, 20 ccs. of which are injected slowly into the median basilic vein. The patient may complain of slight flushing or nausea during the injection but this quickly passes off. A few complain of pain along the course of the vein to the shoulder. Intravenous pyelography can be carried out quite successfully on out-patients, whereas it is not advisable to perform retrograde pyelograms on such patients. Intravenous pyelography also furnishes information about kidney function. Delay in the appearance of the shadow of the calyces indicates diminished kidney function and the relative efficiency of the two sides can thus be easily compared by noting the time of appearance of the shadow on each side

and the density of each. The findings agree closely with the information obtained from indigo carmine tests and together they give very complete information of the changes in structure and function of the urinary tract during pregnancy. In the normal non-pregnant state it is difficult to obtain satisfactory shadows of the ureters by this method and it is almost impossible to see the whole length of the ureter at one time. If the upper portion of the ureter is showing, the lower portion will be empty so that to get a complete pyelogram of the ureter, several plates are necessary. The same is true of the kidney pelvis, for unless the photograph is taken just before it empties its contents the shadow may be very unsatisfactory. In the normal non-pregnant subject the best time to take a photograph of the kidney is 5 to 10 minutes after injection of uroselectan. In some cases, owing to overaction of the pelvis and calyces, a satisfactory shadow cannot be obtained. During pregnancy the difficulty seldom arises as the stasis present is usually sufficient to obviate this. The calyces, kidney pelvis and ureter down to the pelvic brim at least, show clearly on the same plate. Where there is marked delay in excretion on one side, the shadow on the normal side may

have practically disappeared before the shadow on the affected side had become satisfactory. This is illustrated by the case of Mrs. B., a primigravida in the seventh month of pregnancy. Fig.37, a pyelogram taken 7 minutes after injection of uroselectan, shows the left urinary tract slightly dilated down to the pelvic brim. On the right side, only the calyces show and are seen to be dilated. In Fig.38, a pyelogram at 20 minutes, the left renal tract is unchanged and on the right side the kidney pelvis now shows clearly. Fig.39, a pyelogram at 40 minutes, now shows the right ureter down to the pelvic brim, moderately dilated; the left is still unchanged. (This does not mean that no uroselectan reached the right ureter until 40 minutes after injection but that it was not in sufficient concentration to give a shadow until then.)

In the puerperium the stasis has usually disappeared owing to the removal of the pressure of the pregnant uterus and so intravenous pyelography is unsatisfactory. Not only has the stasis disappeared but the kidney has not recovered fully from the effects of the dilatation during pregnancy and is not excreting so rapidly as normally, with the result that there is not enough uroselectan in the

kidney pelvis at any one time to give a satisfactory shadow. This has led, as will be shown later, to erroneous statements as to the rate of involution of the dilatation of the urinary tract in the puerperium. This is illustrated by the following pyelograms in the case of Mrs. R., a multipara. Fig.40, an intravenous pyelogram in the seventh month of pregnancy, shows dilatation of both urinary tracts, especially of the left kidney pelvis and calyces. An intravenous pyelogram, taken 10 days post-partum, in Fig.41 suggests that the dilatation has disappeared but one month later a catheter pyelogram — Fig.42 — shows that there is still very considerable dilatation, with narrowing of the ureteropelvic junction on both sides.

Retrograde pyelography is very useful in the puerperium or in the non-pregnant where there is no stasis in the ureter, but it gives little indication of the function of the kidney. I seldom use it now in pregnancy but nearly always in the puerperium.

(d) Graphic representation of ureteral function. As atony of the ureteral musculature is believed to be an important factor in the production of the changes in the urinary tract in pregnancy, an accurate method of studying

variations in ureteral tone would contribute to a better understanding of the phenomena. I have devised a simple apparatus for the estimation of ureteral tone on the same lines as Trattner's hydrophoragraph, described on page 26. A catheter is introduced into the ureter of such a diameter as to fit it exactly. It is connected by means of rubber tubing to a water manometer and the height to which the ureter can force a column of water is measured. The catheter is then connected to a reservoir into which the urine drains. This reservoir is of such a size that fairly large quantities of urine collected from the ureter will make very little difference to the height of the fluid in it. The ureter, therefore, for all practical purposes is acting against a constant pressure. From the top of the reservoir a tube is led off and connected to a float, recording lever and drum. The urine displaces air which causes the lever on the drum to rise and the rapidity with which the lever rises gives a record of the rate of excretion of urine, and although it is only a volume recorder, peristaltic waves are sometimes seen. At intervals the lever has to be brought down to the base line as it tends to rise continuously. The reservoir can be set at different heights and the rate of

outflow of urine in response to varying pressures compared. The rate of expulsion of known quantities of fluid injected into the ureter can also be used as a measure of ureteral tone.

Results

(1) of chromocystoscopy, intravenous pyelography, ureteral catheterisation and separate kidney function tests.

One of the most important contributions to the study of the urinary tract in pregnancy is that of Gremme (1931), who correlated the anatomical changes as seen in pyelograms with the results of the indigo carmine test as an indication of function. He reaches the very important conclusion that dilatation of the urinary tract does not necessarily mean stasis and that there may be delay in emptying the upper urinary tract without the kidney being affected. These conclusions are in my opinion correct but in many respects his work is open to criticism. In the first place, his numbers are small and in studying the sequence of events in the urinary tract during the course of pregnancy he uses different patients at different stages of pregnancy. No attempt has been made to test kidney function, other than by

indigo carmine, which he admits is unreliable during pregnancy, and atony is merely deduced from the appearance of the pyelograms. My observations are based on 150 cases examined once during pregnancy and 94 examined at monthly intervals from the second month of pregnancy onwards, cases being discarded where regular attendance was not obtained. In all cases the urine was sterile at the first visit and, as far as could be judged from the history, there had been no previous urinary infection. In those cases, chromocystoscopy, intravenous pyelography, estimation of urea concentration of the urine from separate kidneys and testing of tone by the apparatus already described were carried out at intervals during the pregnancy. Many of the cases in this series were admitted to hospital for confinement and the investigation of the urinary tract by those various methods carried on in the puerperium to determine the rate of recovery. This investigation has involved over 600 cystoscopic examinations and over 200 X-Ray examinations. There have been no publications on the subject in this country and I have not been able to find any such investigation in the foreign literature where the results were based on repeated examinations of the same cases throughout

pregnancy.

T A B L E II.

Months pregnant.	Primigravidae.		Multiparae.	
	Right.	Left.	Right.	Left.
Over 2 . .	5.0 mins.	4.3 mins.	4.1 mins.	4.0 mins.
" 3 . .	4.0 "	4.6 "	5.4 "	4.5 "
" 4 . .	8.0 "	6.0 "	6.8 "	4.2 "
" 5 . .	11.4+ "	6.0 "	6.7 "	4.3 "
" 6 . .	11.4+ "	6.5 "	5.7 "	4.5 "
" 7 . .	10.4+ "	6.8 "	7.0 "	5.0 "
" 8 . .	7.6+ "	5.0 "	6.7 "	5.0 "

The numbers represent the indigo carmine time in minutes. + indicates that in several of the cases the dye had not appeared at the end of the observation period.

Table II is an analysis of the results of the indigo carmine test performed at monthly intervals during pregnancy in 94 cases. It shows that in primigravidae there is a delay in excretion on both sides, beginning at the fourth month and reaching its maximum at the fifth or sixth month. The delay is more marked on the right side.

In multiparae the Table shows that there is slight delay on the right side but no definite maximum period. On the left side there is a striking absence of delay in excretion at any stage of the pregnancy.

T A B L E III.

Delay	Primiparae	Multiparae
Marked	8 - 24.2%	4 - 13.8%
Moderate	10 - 30.2%	1 - 3.5%
Slight	6 - 18.4%	8 - 27.6%
None	9 - 27.2%	16 - 55.1%
Total	33	29

Table III is an analysis of the amount of delay in excretion present in 62 cases of this series, specially selected because of excellent general health and past history. There is some degree of stasis in 72.8% of primigravidae and only 44.9% of multiparae. Further, in the multiparae the delay in excretion is more often slight. 82.7% of the multiparae and only 45% of the primigravidae had slight or no stasis. Those figures illustrate the fundamental fact that

stasis occurs in the right ureter in the majority of primigravidae and in almost 50% of multiparae. The analysis also brings out a very important point — that the stasis reaches its maximum during the fifth and sixth months and diminishes towards full time. This may be very difficult to demonstrate where the stasis is very marked; indeed, in cases where stasis is very pronounced, no improvement at all may occur. Where stasis is slight as it usually is in the left ureter, this improvement near full time can be demonstrated very convincingly. This will be illustrated in the description of individual cases. In the puerperium the delay in emptying of the ureter, which is present during pregnancy, disappears as a rule very quickly. This does not necessarily mean that the ureter has returned to its former dimensions but, as I shall show later, is explained by the removal of the pressure exerted by the pregnant uterus at the pelvic brim. The tone of the ureter actually is often much less than during pregnancy.

Information about the cause of the delay in excretion can be obtained by the passage of a ureteral catheter. Details of the method are given in section (b) of Methods. It shows that in practically every case the

delay in excretion is due to obstruction at or above the level of the brim of the bony pelvis, for immediately the catheter passes this point, urine drains away quickly and if the catheter is withdrawn below this point, the flow of urine stops. As is seen on page 82, the use of a ureteral catheter in conjunction with the indigo carmine test furnishes accurate information regarding the degree of stasis in the upper urinary tract. Although this simple experiment indicates obstruction of the ureter, many workers still deny that this actually occurs. I shall show conclusively by various methods that the ureter is compressed by the pregnant uterus against the psoas muscle.

There are great individual variations in the behaviour of the urinary tract at the various stages of pregnancy and to study them in detail it is necessary to correlate the information obtained by the various methods already outlined. The following is a short summary of the more common changes in the urinary tracts during the course of pregnancy. In some cases as early as the second month there is delay in excretion and irregular action of the ureters, pointing to diminished tone. In the third month there is more regular action of the ureter with improvement

in elimination, probably evidence of recovery of tone. At the fourth month irregular action recurs on both sides. On the right this becomes progressively worse, until the sixth month. From this point onwards in some cases, the elimination improves so that near full time there is very little delay in excretion and the ureteral action is regular. In other cases, however, although the ureteral action becomes regular the delay in excretion remains marked. In this type of case, the urinary tract from the pelvic brim upwards is never completely emptied and acts like a reservoir, the mechanism of emptying resembling that found in overflow incontinence of the bladder. The indigo carmine appearing in the bladder from the right side is therefore very dilute. The left ureter continues to have irregular action from the fourth month until the seventh or eighth month, but near full time the action becomes more regular and the good concentration of indigo carmine indicates that there is little dilatation. In other cases no primary diminution in tone is seen, both ureters contracting regularly and vigorously. Some of those cases show very little change throughout the whole of pregnancy, apart from slight irregularity in rhythm from the fourth to the seventh month. In others a

sudden change occurs between the fourth and the fifth months, marked delay in excretion developing very quickly. In a few cases the delay in excretion makes its appearance much later in the pregnancy, as late as the seventh or eighth month. Usually those changes in the urinary tract are not accompanied by any symptoms but in about 15 per cent. of cases pain is complained of and this usually comes on about the fourth or fifth month. It is due to spasm of the ureter. In some of those cases the urinary tract is very dilated but in others pain may be very severe with practically no dilatation of the tract. It is not possible to predict from the condition of the urinary tract in the early months what will happen later in the pregnancy. Those changes occur in cases in which the urinary tract is normal before pregnancy. There is great variation in the extent to which the function of the kidney is affected. In some, gross dilatation of the ureter and kidney pelvis may occur with little disturbance of kidney function as judged by the rate of appearance of the shadow in an intravenous pyelogram and the concentration of urea in the urine. In others there may be only moderate dilatation of the kidney pelvis and calyces and slight dilatation of the ureter and yet very severe disturbance of kidney function. In the puerperium the stasis quickly

disappears, usually within a fortnight, but the dilatation persists for much longer and in some cases where it has been very marked the urinary tract may never return to normal. In normal cases where the degree of dilatation has been moderate, the tract will usually have returned to normal within 2 months.

The following cases illustrate the different types of response to pregnancy.

(1) The first three show primary atony with temporary improvement followed by atony and dilatation at the fourth month and improvement in the later months.

Mrs. C., a primigravida, case sheet no.1. At the third month very irregular ureter action and, as seen from the pyelogram, Fig.43, the ureters are dilated, kinked and atonic. At the fourth month the elimination is normal and a pyelogram, Fig.44, shows the left renal tract to be undilated and the right acting so well that a good photograph could not be obtained. At the fifth month an indigo carmine test shows that there is marked atony and delay in excretion at both sides; this is confirmed by the pyelogram, Fig.45. In the eighth month the indigo carmine test shows that elimination from the left renal tract is now normal again, but there is still marked stasis on the right side. A pyelogram, Fig.46, shows that, despite the improved elimination on the left side, the left urinary tract is still dilated to much the same extent, while the right is further dilated and the ureter is now kinked. Pyelitis developed at this stage.

This case illustrates a most important point in a problem

which will be discussed later, namely, that stasis preceded the onset of infection, and infection occurred in the right ureter in which there was stasis and not in the left where there was no stasis.

The urine became sterile shortly after the end of the pregnancy. During this patient's second pregnancy repeated investigation was again carried out and she again showed atony and stasis at the fifth month but from then until the end of the pregnancy, the elimination from both urinary tracts was normal. Pyelograms in the later months of pregnancy show exactly the same amount of dilatation as in the first pregnancy.

This observation is also extremely important, because it shows that, although the same amount of dilatation was present in both cases, stasis occurred in the first pregnancy and not in the second. The tone of the right ureter was equally poor in both pregnancies, as measured by the graphic method and it appears as if the only varying factor was the tone of the abdominal wall musculature. Dilatation of the ureters without stasis is relatively common in multiparae and uncommon in primigravidae.

Mrs. G., a multipara, case sheet no.2. At the third month there was very irregular action of the ureters and a pyelogram shows atony of both ureters, with some dilatation and kinking. At the fifth month the indigo carmine test still shows irregular action of the ureters and the pyelogram, Fig.47, shows very clearly kinking and

dilatation of both renal tracts especially of the right. At the ninth month the pyelogram, Fig.48, shows that the left renal tract is now undilated and free from kinks. The indigo carmine test shows that elimination is normal. On the right side the ureter cannot be seen except just below the kidney pelvis, due to the fact that the dilated ureter is now compressed against the psoas muscle along the greater part of its course in the abdomen, whereas in the pyelogram at the fifth month, Fig.47, the ureter was compressed only at one point at the level of the pelvic brim.

This case shows clearly that the atony which was present early in the pregnancy diminished in the later months.

Mrs. F., a primigravida, case sheet no.3. The indigo carmine in the third month showed irregular action of the ureters which by the fourth month disappeared. The pyelogram, Fig.49, taken in the fourth month, shows very little abnormality beyond slight kinking of the ureters. In the fifth month the indigo carmine test shows irregular function especially on the right side and the pyelogram, Fig.50, shows both urinary tracts, especially the right, dilated and kinked to the brim of the pelvis. At the eighth month the pyelogram, Fig.51, shows that the left urinary tract is now undilated and straight, and the right ureter can only be distinguished with difficulty, the point of obstruction having been transferred to the level of the ureteropelvic junction. The inner margin of the right kidney pelvis is straight, being flattened by the border of the psoas muscle.

The pyelograms show very clearly the improvement in tone of the left urinary tract and the transference of the point of obstruction up towards the kidney as pregnancy advances, on the right side.

(2) The next case illustrates irregular emptying of both ureters in the early months of pregnancy, with improvement of function on the left side in the later months of pregnancy and deterioration on the right. On the left side elimination improves and the dilatation of both kidney pelvis and ureter diminishes. On the right side the action of the ureter improves but the dilatation of the kidney pelvis and calyces increases, and they are now never empty.

Mrs. McF., II-para, case sheet no.4. In the sixth month the indigo carmine test showed that after 18 minutes no movement occurred at either ureteral orifice, but on stimulation with abdominal massage the ureters emptied large quantities of deeply stained urine in repeated and prolonged contractions. The pyelogram, Fig.52, taken 4 minutes after giving uroselectan, shows both urinary tracts apparently undilated but the ureters kinked. The pyelogram, Fig.53, at 20 minutes, shows both urinary tracts dilated down to the pelvic brim. The photograph was taken just before emptying occurred as another pyelogram taken some minutes later gave the same appearances as in the first pyelogram. A pyelogram, Fig.54, taken at the end of the seventh month, shows that the left urinary tract is less dilated than in the sixth month, but displaced laterally, while on the right side the ureter does not show. The calyces and kidney pelvis on the right side are, however, more dilated than at the sixth month and are now constantly distended. This case also shows the change of the point of compression on the right side. In the ninth month the left urinary tract in the pyelogram, Fig.55, is seen to be even less dilated but the ureter is now flattened along the outer border of the psoas muscle. The right urinary tract is little changed. As is seen from the indigo carmine test the right ureter is now contracting vigorously and regularly, although there is still great delay in appearance of the

dye. It is certain that the tone of the right ureter has now improved and that the delay in appearance of the dye is due to the dilatation of the calyces and kidney pelvis, which still persists.

(3) The next case shows atony and stasis with very little dilatation.

Mrs. U., a primigravida, case sheet no.5. In the fifth month there was irregular action of both ureters, especially the right, and only slight kinking and dilatation of both ureters down to the pelvic brim, as shown in the pyelogram, Fig.56. In the last month of pregnancy the indigo carmine test showed elimination to be normal on both sides and there was no dilatation of the ureters.

This is an example of a case where the atony present at the fifth month was not sufficiently severe as to persist and by the end of pregnancy had completely disappeared.

(4) The next case is one of marked dilatation without stasis.

Mrs. L., a multipara; in the seventh month a pyelogram, Fig.57, taken at 5 minutes after injection of uroselectan, shows both urinary tracts — the left normal and the right very dilated. In this case the ureter was involved very much more than the calyces of the kidney. The indigo carmine test showed that there was no delay in excretion from either side.

In this pyelogram it is interesting to note that the pelvic portion of the left ureter shows clearly. In the second

half of pregnancy in healthy women, this is sometimes possible on the left side but almost never on the right. I explain this in the following way. In the early months of pregnancy a general dilatation of both ureters occurs and intravenous pyelograms at this stage show both ureters down to the bladder, the widest part being the middle third, which is normally the widest portion. In the second half of pregnancy the uterus presses firmly on the right ureter, causing dilatation and stasis above the point of compression and narrowing of the ureter below that point, so that only small quantities of urine escape past the obstruction at a time and are carried away quickly into the bladder by the undilated lower part of the ureter. Therefore, in intravenous pyelography the lower part of the right ureter does not show, as there is not enough uroselectan in it at a time to give a shadow. On the left side, the obstruction is usually very much less, so that the uniform dilatation, characteristic of the early months, is not disturbed, and in an intravenous pyelogram the whole ureter shows down to the bladder, with the exception of a small portion in the neighbourhood of the pelvic brim, where it is compressed by the uterus. Where there is more obstruction in the left ureter, the same conditions are brought about as on the right

side and the pelvic portion of the left ureter does not show.

(5) The following two cases illustrate increased delay in excretion by the kidney with advancing pregnancy.

Mrs. McE., a primigravida, case sheet no.6. At the end of the fourth month the indigo carmine test shows the elimination from the left side to be normal but there is delay in emptying and atony on the right side. The pyelogram, Fig.58, 7 minutes after injection, shows on the left side the ureter slightly dilated and the calyces and kidney pelvis normal; on the right, the calyces and kidney pelvis dilated and only a small part of the ureter showing. In the plate taken 30 minutes after injection, Fig.59, the right ureter is seen to be dilated down to the pelvic brim. At the sixth month the indigo carmine shows the left side to be normal and that there is still marked stasis and delay at the right side. A pyelogram taken at 7 minutes after injection, Fig.60, shows the left urinary tract to be the same as before and that on the right side the calyces only are showing. At 30 minutes after injection a pyelogram, Fig.61, shows the kidney pelvis now defined clearly and more dilated than before. The pyelogram at 40 minutes after injection, Fig.62, shows the ureter no more dilated than before but displaced laterally. In the ninth month the left side is still acting normally but on the right side there is still further delay in the appearance of any shadow and it takes 60 minutes for it to become as clear as it was after 40 minutes in the sixth month.

In this case the ureteral tone was very good throughout the whole pregnancy even on the right side, but a progressive delay in excretion by the kidney occurred as pregnancy advanced.

Mrs. A., a primigravida, case sheet no.7. At the third month the indigo carmine test proved elimination to

be normal at both sides and the tone was found to be extremely good. At the end of the fourth month stasis had developed on the right side. The pyelogram taken 7 minutes after injection, Fig.63, shows a normal left urinary tract, with only a faint shadow of the calyces on the right side. 20 minutes after injection, a pyelogram, Fig.64, now shows the right kidney pelvis and calyces clearly, moderately dilated. The urea concentration of the urine from the right kidney was 0.4 per cent., while that from the left was 1.14 per cent. In the seventh month, the indigo carmine test showed that delay was still present at the right side and even in a plate taken 25 minutes after injection, no shadow was obtained on the right side. Later plates showed that there was no increase in the amount of dilatation of the right kidney pelvis or ureter. The tone of the right ureter at the seventh month was extremely good.

This case is a most striking example of serious disturbance of kidney function with only moderate dilatation of the urinary tract and a ureter of extremely good tone. The extremely low figure for urea concentration in the urine from the right kidney is unusual in uninfected cases but it may be explained by the following observations. The ureteral tone was very good and the abdominal wall was tense, so that the intra-ureteral pressure was probably very high. As was stated in Chapter I, page 27, this affects the rate of excretion by the kidney. In this case also the patient had severe cardiac disease, which would possibly diminish the circulation in the renal glomeruli, which according to Winton (1931) lessens the power of the kidney to concentrate urea.

(6) The following cases are examples of gross dilatation of the ureters in pregnancy with slow recovery in the puerperium.

Mrs. Kidd, a primigravida, case sheet no.8, was admitted for Caesarean Section because of contracted pelvis. On account of the bony deformity and small stature, the abdomen was pendulous. The pyelogram, Fig.65, shows that in both ureters the site of obstruction is very low at full time, even on the right side. The plate shows that both ureters are displaced laterally to the outer border of the psoas muscle, and where they cross the psoas muscle to enter the pelvis they are extremely kinked. It is interesting to compare this pyelogram with the sketch in Fig.34 of the ureters in situ in a similar case, which died a few hours after Caesarean Section. Despite the gross dilatation on the right side a good shadow of the kidney pelvis appeared in 7 minutes, indicating that the kidney function was not greatly affected. This was confirmed by the results of the urea concentration test, which on one occasion was higher at the right side than the left, for which the explanation has already been given. On the tenth day post-partum the right ureter was found to be very sluggish, as no movement of the orifice occurred in 12 minutes. This is in direct contrast to the condition present during pregnancy where, although there was delay in appearance of the dye, the ureter was contracting vigorously and frequently. A catheter pyelogram made at this stage, Fig.66, shows that the lateral displacement has now disappeared and there is slight diminution in the size of the tracts, especially the left. Much more striking, however, is the loss of tone which, as is seen on the case sheet, is enormous. 5 weeks post-partum the ureters are emptying normally but the tone is still very deficient in the right ureter. 5 months post-partum the tone of the right ureter has now returned to the level at which it was at the end of pregnancy.

This illustrates the fact that although the delay in emptying

of the ureter may disappear fairly quickly in the puerperium, this is not due to involution of the dilatation and improvement of tone, which indeed becomes very much less, but due to removal of obstruction by the pregnant uterus.

Mrs. G., a II-para, developed an enormous dilatation of the calyces, kidney pelvis and ureter on the right side in the sixth month of pregnancy, as is shown in the pyelogram, Fig.67. A catheter pyelogram, Fig.68, taken at the same stage of pregnancy, shows clearly that the point of obstruction is at the pelvic brim. It will be noted that the shadow of the catheter pyelogram is much smaller than the intravenous due to the relief of tension. At full time the point of obstruction on the right side has been transferred higher up the ureter and the next pyelogram, Fig.69, taken $3\frac{1}{2}$ months post-partum still shows marked dilatation on the right side and some dilatation on the left, despite the fact that the indigo carmine excretion time has long since returned to normal. One observes that in both ureters the shadow stops short at the outer border of the psoas muscle and difficulty was encountered in obtaining a satisfactory shadow of the ureters below this point.

Despite this enormous deformity the only urinary symptom complained of during the pregnancy was a dragging pain on the right side. There was, however, marked general debility.

The following case illustrates several interesting points.

Mrs. W., a primigravida, case sheet no.9, 10 weeks amenorrhoea when first examined. Indigo carmine test reveals very irregular action at the right ureteric orifice. The pyelogram, Fig.70, taken 7 minutes after

uroselectan, shows that the right kidney pelvis and calyces are dilated and kinking at the junction of pelvis and ureter is evident. Flattening of the kidney pelvis by the outer border of the psoas muscle can be plainly seen on the pyelogram. In the fourth month of pregnancy the ureter function as shown by indigo carmine was much improved, and the tone of the ureter as estimated by the graphic method was good. At the sixth month the function of the left urinary tract was normal and at the right side the ureter was contracting vigorously; the tone was found to be very good but there was nevertheless marked delay in appearance of indigo carmine. These observations are explained by the X-Ray photographs. The pyelogram in Fig.71, taken at 7 minutes, shows the left urinary tract clearly and almost undilated, and on the right side an extremely faint shadow of dilated calyces. The pyelogram at 20 minutes, Fig.72, shows the left side very clearly, and no shadow of the ureter on the right side. At 75 minutes the pyelogram, Fig.73, shows the right ureter clearly, displaced medially and only slightly dilated. This agrees with the cystoscopic findings, as it confirms the fact that the ureter is emptying efficiently. It also shows that the delay in appearance of the indigo carmine is due to interference with kidney function and stasis in the renal pelvis.

This illustrates a very important point, namely, that in some cases the atony may be largely confined to the kidney pelvis and calyces. In this case near full time the excretion from the left kidney was found to be less satisfactory and the pyelogram, Fig.74, shows that the left urinary tract is now dilated down to the level of the pelvic brim. It is also somewhat displaced outwards. As the test for tone demonstrated that there was no falling off in tone, the change must be due to increased pressure on the ureter, so that one concludes

that individual anatomical variations must govern to a certain extent the distortion of the urinary tract produced and its time of onset. This case also shows that even as early as the tenth week, there may be more disturbance of function in the right ureter than in the left. This is very difficult to explain in a primigravida such as this patient. In multiparae it may be accounted for by the fact that the ureter has not completely recovered its tone after the previous pregnancy.

The following case shows how sudden the onset of stasis may be and that where bilateral it predisposes to bilateral pyelitis, further emphasising the fact that stasis predetermines the onset of infection.

Mrs. R. At the end of the third month the indigo carmine test showed no stasis and this was confirmed by X-Ray photographs. 3 weeks later, stasis was present on both sides and pyelography showed bilateral dilatation of the urinary tracts. At the sixth month a pyelogram, Fig. 75, shows this dilatation only slightly more marked and within a short time an acute attack of bilateral pyelitis of pregnancy developed.

The next two pyelograms show variations in the type of deformity.

Fig. 76 is a pyelogram taken in a primigravida in the seventh month of pregnancy, showing extreme elongation and kinking of the right ureter.

Fig.77 is an intravenous pyelogram taken during the sixth month of pregnancy in a primigravida. It shows dilatation of both urinary tracts and on the right side a kink very high up at the ureteropelvic junction.

(2) The results obtained by experimental work on the tone of the ureter.

The dilatation and stasis produced in the urinary tracts during pregnancy depend upon two factors, the obstruction to outflow caused by the pressure of the pregnant uterus on the ureter and the diminution in tone of the ureteral wall. The pressure exerted by the pregnant uterus probably varies with the tone of the muscles of the abdominal wall, which would account for the increased incidence of gross dilatation in primigravidae, but unfortunately this pressure cannot be accurately estimated. It is possible, however, to estimate the tone of the ureteral wall by the graphic method which I have devised. Previous workers on the ureter in pregnancy have relied on the appearance in pyelograms and the presence or absence of stasis to decide whether atony is present or not, although in non-pregnant women, urologists, notably

Trattner (1932) with his elaborate hydrophoragraph, have used accurate methods of estimating ureteral tone, for some years.

The tone of the ureter was found to vary in different parts of it, as has been pointed out in the non-gravid state by Kreutzmann (1928) and Trattner (1932). This is demonstrated by the case of a healthy primigravida, 10 weeks pregnant, in whom the upper part of the ureter had a tone of 30 cms. water pressure and the lower half, 44 cms.

Fig.78 is a tracing made in a primigravida in the third month, in whom the tone was good — 36 cms. Peristaltic waves are noticed when the catheter is in the upper half of the ureter, and when it is pulled below the brim of the pelvis at the point marked no change is seen, indicating that there is no obstruction at that point. The waves are slightly bigger than before as is to be expected, since the whole length of the ureter is taking part in the waves. At the point indicated, 5 ccs. of ¹~~5000~~ acriflavine solution were injected through the catheter and this caused pain. A continuous contraction of the ureter then occurred, as evidenced by the smooth line traced by the lever. Gradually, however, the ureter resumes its normal action. This

indicates an undilated ureter of fairly good tone, in which there is no obstruction to outflow. This is the normal finding in early pregnancy.

As early as the 18th. week, obstruction to outflow is caused at the level of the pelvic brim by the pregnant uterus. This is illustrated by the following case, in which a tracing, Fig.79, was made in the 18th. week of the first pregnancy.

A catheter was inserted into the right ureter above the pelvic brim and 30 ccs. of acriflavine injected produced no pain, indicating dilatation of the ureter. The ureter expelled the fluid fairly quickly against a moderate pressure. 20 ccs. were again injected to make sure that the upper urinary tract was full. At the point indicated, the catheter was withdrawn to a point below the pelvic brim and immediately the excretion stopped, as is shown in the tracing by the horizontal line. On two occasions when the patient sat up ("s" on the tracing), urine was expelled, but stopped when the dorsal decubitus was resumed. When the patient was turned on to the hands and knees ("H and K" on the tracing), after 8 minutes lying flat during which no excretion occurred, the excretion started again at once and at a rapid rate, indicated by a steep rise in the tracing. Immediately she was put in the dorsal decubitus excretion stopped, until she was again put on the hands and knees.

The pyelogram taken at the same time, Fig.59, shows that the right ureter is dilated from the pelvic brim upwards. This tracing confirms the fact and also gives graphic evidence that when the weight of the uterus is removed from

the pelvic brim by the hands and knees position, the obstruction to outflow is relieved. This case affords clear proof of the obstruction to outflow caused by the pressure of the pregnant uterus at the pelvic brim, beginning as early as the 18th. week. Later in the pregnancy the same experiment was repeated and did not give such striking results, probably because the increased size of the uterus left less room for it to fall forward. As pregnancy advances the pressure exerted by the pregnant uterus is bound to increase. In some cases the pressure of the uterus on the right ureter is relieved by placing the patient in the left lateral position, but not by placing her on the right side.

In cases where the ureteral tone is known to be equal, the amount of dilatation and stasis is found to vary considerably. This must be due to variations in the amount of pressure exerted by the uterus on the ureter. This is demonstrated by a comparison of the following two cases, A and B, where the ureteral tone was found to be equal in the seventh month of pregnancy.

In A, Fig.80, lower tracing, there was no delay in excretion as judged by the indigo carmine test. In B, Fig.80, upper tracing, there was marked delay at the

right side. In both cases the urinary outflow stopped when the pressure was raised to 20 cms., in fact, in B at a pressure of 24 cms. urine flowed back into the ureter, shown by the fall in the tracing. In A, who had no stasis, excretion continued when the catheter was pulled below the brim of the pelvis, whereas in B excretion stopped, to be re-established when the hands and knees position was assumed.

The pressure exerted on the ureter at the pelvic brim must have been greater in B than in A. The intravenous pyelogram, Fig.81, confirms the fact that there was practically no dilatation of the right ureter in A, the case without stasis.

Even where the tone of the ureter is extremely good, marked dilatation of the urinary tract may occur if the pressure at the pelvic brim is sufficiently great.

Fig.82 is a pyelogram in a healthy primigravida in the eighth month of pregnancy, showing marked dilatation and kinking of the urinary tract above the pelvic brim although the tone of the ureter was over 30 cms. — much better than in either of the preceding cases. Fig.83 is the tracing in this case made at the same time, with a catheter in the right ureter. The sharp response to the instillation of 10 ccs. of acriflavine indicates good tone of the ureter. When the catheter is pulled below the pelvic brim the excretion immediately stops and no urine passes till the patient is placed in the left lateral position. The tracing shows that the right lateral position does not cause excretion to restart, but replacement in the left lateral position causes the lever to rise again.

The abdominal muscles in this patient were well developed and tense and this may afford the explanation of why the pressure at the pelvic brim was so great in this case. It is evident, therefore, that there are two important factors in the production of stasis — the tone of the ureter and the pressure of the uterus on it at the pelvic brim. The pressure of the uterus is necessarily an ever-increasing one so that the decrease in stasis which takes place near term despite this, must depend on improvement of ureteral tone.

The following case confirms in a very convincing manner the fact that the uterus compresses the ureter against the psoas muscle and also shows the type of tracing in a ureter of poor tone. Fig. 84 is a retrograde pyelogram in a case of pyelitis of pregnancy in the seventh month, a II-para, showing dilatation and kinking of the whole urinary tract. The portion of the ureter which does not show in the picture is the part flattened against the psoas muscle by the pressure of the uterus. The area of obstruction in the ureter corresponds to the area occupied by the psoas muscle at this point, both in width and direction. (In a pyelogram taken in the puerperium this part of the ureter

shows clearly, now that the compression by the pregnant uterus is removed.) The pelvic portion of the ureter is also dilated. This is sometimes found in infected cases but very seldom in uninfected cases. With a catheter in the upper half of the right ureter, the tone was found to be 15 cms. but by increasing the intra-abdominal pressure, by making the patient sit up or strain, the column could be raised to 30 cms. or more. As soon as the intra-abdominal pressure was lowered the level fell to 15 cms.

The tracing in Fig.85 shows that with the pressure low, 2 to 3 cms., the excretion of urine was rapid, indicated by an abrupt rise in the lever, but as soon as the pressure was raised the rate of excretion fell off, but could be increased by making the patient sit up. In the upper part of the tracing at the point indicated when the catheter was pulled below the pelvic brim excretion stopped, as indicated by the horizontal line. Sitting up was again followed by a rise in the lever. This is due to the fact that the increased intra-abdominal pressure so produced emptied the atonic pelvic portion of the ureter. When the intra-abdominal pressure was again increased, however, a rise in the lever was not recorded, since the lower portion of the ureter had already been emptied and urine had not yet come from above the pelvic brim. As is seen in the tracing, massage over the kidney caused some urine to flow over into the lower half of the ureter but this occurred in much larger amounts when the patient was turned on to the hands and knees. This experiment was repeated and on this occasion the hands and knees position was combined with massage over the kidney, and a much larger quantity of urine flowed over the pelvic brim. This is seen in the dramatic rise

at the end of the tracing. When the patient sat up the lever again rose, since the pelvic portion of the ureter had meantime been filled from above. When she again sat up, no rise of the lever occurred, as the pelvic part of the ureter was now empty.

In this case, therefore, the right ureter was compressed at the pelvic brim and so long as the catheter was above this level increase of intra-abdominal pressure, by tightening the recti muscles, increased the rate of excretion, whereas, with the catheter below the pelvic brim, increased intra-abdominal pressure increased the compression of the ureter at the pelvic brim and urine did not escape. This observation indicates that the tone of the abdominal muscles is important in determining the amount of compression of the ureter at the pelvic brim.

In certain primigravidae examined in the later months of pregnancy, the tone of the ureter was very good and, in spite of tense abdominal muscles, there was very little dilatation of the right ureter. The indigo carmine test showed, however, that although the right ureter was contracting vigorously the appearance of indigo carmine was delayed and the concentration poor. The intravenous pyelograms demonstrated that this was due to delay in excretion by the kidney, as the calyces were dilated and were

very slow to appear. The fact that the right kidney function was affected was confirmed by the result of the urea concentration test in the urine from separate kidneys, the urea concentration being very much lower at the right side than at the left. The cases of Mrs.A. (case sheet no.7) and Mrs.W. (case sheet no.9) are examples of this condition. In Mrs. A. especially, the tone of the right ureter was extremely good and the kidney function was very seriously affected, the urea concentration on the right side being 0.4 per cent., while on the left it was 1.2 per cent. It is possible that where the ureteral tone is poor and more dilatation of the ureter occurs, the kidney escapes damage, owing to the reservoir-like action of the ureter.

In the puerperium the uterus quickly becomes a pelvic organ and no longer presses on the ureters at the pelvic brim, so that stasis quickly disappears, as indicated by improvement in the indigo carmine excretion time. This is confirmed graphically by the following case, Mrs.P., a primipara, case sheet no.10, who had a tracing (Fig.86, upper tracing) made a few days before the onset of labour. With the catheter in the right ureter above the pelvic brim, the rate of excretion after injection of 20 ccs. of acriflavine into the ureter is rapid, until the catheter is withdrawn

below the pelvic brim, when excretion practically stops, although massage over the kidney caused a little urine to be expelled. In the puerperium (Fig.86, lower tracing), the same procedure 12 days after delivery was carried out and on this occasion when the catheter was withdrawn below the pelvic brim the flow of urine was not checked. This is represented graphically in the steady rise of the lever.

Although the stasis disappears in the puerperium, there is at the same time a rapid falling off in ureteral tone. This was first suspected by the evidence of chromocystoscopy, for while just before labour the efflux from the ureters is usually vigorous, in the puerperium the efflux may be feeble and irregular in rhythm. The actual indigo carmine excretion time is usually, however, less in the puerperium. The character of the efflux may revert to what is seen in the early stages of pregnancy in some cases, for example, the right ureteral orifice may remain motionless for as long as 8 to 10 minutes and then expel large quantities of urine, deeply stained with indigo carmine in a series of contractions with only a few seconds between each. This is also confirmed graphically in the following case.

Mrs. McG., a primipara, case sheet no.11. At full time the indigo carmine excretion time was 6 minutes at both sides and the ureteral action was regular. A catheter was inserted into the right ureter above the pelvic brim, and the tracing made is shown in Fig.87, upper tracing. With the pressure at 5 cms. 10 ccs. of acriflavine were injected and an abrupt rise of the lever occurred. The waves on the tracing indicate that the ureter is active. When the pressure was raised to 20 cms. excretion stopped but, on injection of a further 10 ccs., excretion again occurred. 10 ccs. were again injected to ensure that the tract was full and the catheter withdrawn below the pelvic brim. Very slight excretion occurred until the patient was placed in the left lateral position, when the urine was excreted fairly quickly and stopped immediately the patient was placed on the back again. When placed on her right side, excretion did not occur.

In this case, therefore, the activity of the ureter was good and there was no delay in excretion (indigo carmine, right side 6 minutes, good concentration). It is obvious, however, that the ureter was compressed at the level of the pelvic brim and that some force was required to expel urine past that point. This was only accomplished when the ureter was completely filled. In passing, it may be mentioned that in cases where the upper part of the ureter is emptied by a ureteral catheter the ureter will not contract until the kidney has secreted enough urine to fill it completely. In cases where the ureter is very dilated, with a capacity of as much as 50 ccs., it will not contract for over an hour.

On the ninth day post-partum in the case of Mrs. McG., the indigo carmine excretion time was 5 minutes from the left side and in 11 minutes no dye had appeared at the right side, and there was no movement of the orifice. A catheter was passed into the right ureter and urine deeply stained with indigo carmine was found above the brim of the pelvis. A tracing, Fig.87, lower tracing, was again taken. 10 ccs. of acriflavine on this occasion evoked no response. Siphonage was required to drain off any urine, as is shown in the tracing. Immediately a pressure of 5 cms. was imposed on the ureter, excretion stopped. Sitting up caused a sudden excretion of urine, shown on the tracing by a rapid rise of the lever. Coughing and laughing were registered on the tracing by small waves, thus demonstrating how sensitive the ureter was to changes in the intra-abdominal pressure. When the catheter was pulled below the pelvic brim, no change resulted.

The right ureter, which before labour was of good tone, became very atonic in the puerperium.

The atony varies greatly in different cases. It is more marked on the right side (the dilated side) than on the left (the undilated side). In fact, the left side may show no appreciable diminution in tone in a case in which the right side shows a considerable falling off in tone. In some cases in which the right ureter is scarcely dilated during pregnancy, this atony in the puerperium may be very slight. It appears, therefore, to occur for the most part where the ureter has been stretched during the pregnancy. It reaches its maximum about the eighth to the tenth day

post-partum, although there appear to be exceptions to this.

To summarise the findings regarding the tone of the ureters obtained by chromocystoscopy and the graphic method described here, the sequence of events in pregnancy and the puerperium appears to be as follows. In the majority of cases there is a slight diminution of tone in the early months of pregnancy, which either remains stationary or becomes worse till the end of the sixth month. In those cases, dilatation may be marked. From then until delivery there is a steady improvement in tone and in the puerperium, especially on the right side, a sudden and severe falling off in tone occurs, which may not return to normal for several months. In other cases, loss of tone in the early months is very much less and the falling off in tone in the middle three months of pregnancy is also less. In those cases as a rule, dilatation of the right ureter is not marked and in the puerperium the falling off in tone may be only slight.

The following four cases illustrate the primary lowering of tone in the ureters with improvement near full time and varying degrees of atony in the puerperium, mostly slight.

Mrs. G., a primigravida.

In the 3rd.month	. . .	stasis none, ureteral tone	28 cms
" " 4th.	" . . .	" " " "	24 "
" " 5th.	" . . .	" " " "	28 "
" " 6th.	"	slight delay in emptying of right ureter and ureteral tone	40 "
" " 7th.	"	no delay.	
" " 8th.	" "	ureteral tone	45+ "
On the 9th.day post-partum,		ureteral action regular and ureteral tone	50 "

Mrs. O'H., a primigravida.

In the 3rd.month	. . .	stasis none, ureteral tone	32 cms
" " 4th.	"	very slight stasis,	32 "
" " 5th,	"	" " " "	32 "
" " 6th.	"	" " " "	36 "
" " 7th.	"	" " " "	45 "
Just before full time,		very slight stasis	50 "
2 days post-partum	. .	stasis none,	42 "
9th.day	" " . .	" " " "	26 "
6th.week	" " . .	" " " "	60 "

At the 6th. week post-partum, the tone was better than it had ever been during the pregnancy — probably at its normal value.

Mrs. S., a primigravida.

In the 4th.month	. . .	stasis none, ureteral tone	36 cms
" " 5th.	" . . .	" " " "	30 "
" " 6th.	" . . .	" " " "	30 "
" " 7th.	" . . .	" slight,	30 "
" " 8th.	" . . .	" none,	45 "
" " 9th.	" . . .	" " " "	45 "
3rd.day post-partum	.	" " " "	28 "
8th. " " "	.	" " " "	50 "

Mrs. Shields.

In the 3rd. month	. . .	stasis none,	ureteral tone	26 cms
" " 4th. "	. . .	" "	upper half	26 "
" " 5th. "	. . .	" "	lower half	36 "
" " 6th. "	. . .	" "		
" " 7th. "	. . .	" "	ureteral tone	36 "
" " 8th. "	. . .	" "	" "	50+ "
9th. day post-partum	.	" "	" "	18 "

At the 9th. day post-partum, there was marked irregularity of ureter action. After 1 c.c. of pituitrin, tone rose to 42 cms.

This patient had a relatively small child and the abdominal wall was fairly lax, which may explain the lack of stasis at the 5th. month although the tone was relatively poor.

There may be marked lowering of tone on the right dilated side in the puerperium, with very little change on the left undilated side. This is shown in the case of Mrs. M., a primigravida, where in the ninth month there was moderate degree of stasis on the right side. The tone of the right ureter was 33 cms. and of the left 44 cms. On the ninth day post-partum, the left side showed no stasis whereas at the right side there was no movement in 11 minutes. The tone of the right ureter was 12 cms. and of the left 42 cms. This showed that the falling off in tone occurred on the dilated right side.

The following cases illustrate the rate of recovery in the puerperium.

Mrs. B., a primigravida, had no stasis before labour and the tone of the right ureter was 26 cms. On the 14th. day post-partum the right ureter tone was 8 cms. 3 months post-partum the tone was 20 cms. and 5 months post-partum, 36 cms.

Mrs. M., a primigravida, had moderate stasis at the left side and marked stasis at the right. In this case at the 8th. month the urea concentration at the right was 0.63 per cent. and that at the left was 0.95 per cent., and the tone was 36 cms. at the right side. Labour was induced on account of albuminuria. On the 5th. day post-partum there was no stasis at either side and the tone of the right ureter was 24 cms. On the 11th. day post-partum there was marked irregularity in the action of both ureters and the tone of the right ureter was 12 cms. and of the left 18 cms.; the urea concentration on the right was 0.7 per cent., while that on the left was 1 per cent.

This urea observation illustrates the most important fact that the damage to the kidney resulting from the dilatation persists for some considerable time after delivery.

Clinical Aspect.

As a rule those changes in the urinary tract in pregnancy are not accompanied by any clinical manifestations, except where there is marked interference with the function of both kidneys. In a certain number of cases, pain is complained of either over the kidneys or along the ureters.

No uniform abnormality is associated with pain. An apparently normal urinary tract, as demonstrated by pyelography, may be the seat of severe pain, so that pyelography is of little aid in coming to a diagnosis. If the pain is of renal origin, the passage of a ureteral catheter will cause it to disappear immediately. This should always be done in differentiating between appendicitis and pain of renal origin during pregnancy. Where the urine is infected and pain is present, the passage of a ureteral catheter will usually also result in the relief of pain, although the relief may not be so complete as in uninfected cases. In some cases, tenderness over the uterus has been found to be relieved by the passage of a ureteral catheter, showing that it was probably referred from a ureteral spasm. The following cases illustrate the variety of anatomical conditions of the urinary tract which may be associated with pain.

Mrs. C., a primigravida, had an acute attack of pain in the left iliac fossa in the fifth month of pregnancy. The attack was repeated several times and the pain was so severe that morphia was required. A ureteral catheter passed to a point above the pelvic brim on the left side gave instantaneous relief. An intravenous pyelogram taken 7 minutes after uroselectan, Fig. 88, shows a fairly normal left renal tract, except

for slight dilatation in its middle third. On the right side there is marked delay in excretion, characteristic of pregnancy.

Mrs. W., a primigravida, had severe right renal pain in the eighth month of pregnancy, which was relieved by passing a ureteral catheter to a point in the right ureter 20 cms. from the bladder. The pyelogram, Fig. 89, taken 7 minutes after injection of uroselectan, shows no dilatation of the left urinary tract and only slight dilatation of the right, with an acute kink of the ureter.

It is important to note that the catheter relieved the pain immediately, although it was passed to a point below the kink. In my opinion, the distribution of the pain is determined by the situation of the kink, that is, when the kink is near the kidney, the pain and tenderness are over the kidney region and when the kink is lower in the ureter, the tenderness is in the iliac fossa; but since to relieve the pain when it is in the kidney region it is only necessary to pass the ureteral catheter no higher than the brim of the pelvis, the pain irrespective of the site is dependent on pressure of the uterus on the ureter at the pelvic brim. This is confirmed by the fact that pain does not usually occur until the fifth or sixth month of pregnancy. The same thing will be demonstrated regarding the pain and tenderness in pyelitis of pregnancy.

Mrs. C., a III-para, had pain in the right iliac fossa with each pregnancy. In the sixth month of the third pregnancy the left renal tract was normal, as seen in the pyelogram in Fig. 90 and the right tract shows dilatation of the kidney pelvis, kinking of the ureter immediately below the kidney pelvis and no abnormality of the ureter at the pelvic brim in the region of the pain and tenderness. No stasis was present.

Mrs. C., a VI-para, had pain and tenderness in the right kidney region in the last three pregnancies. An intravenous pyelogram taken in the sixth month of the sixth pregnancy, Fig. 91, shows extreme kinking of both ureters just below the kidney. Pain and tenderness were relieved by passing a ureteral catheter to a point above the pelvic brim. There was no delay in excretion here as the shadow of the right kidney was clearly shown in 7 minutes.

The next two cases demonstrate, in contrast to those already shown, the association of stasis and renal pain.

Mrs. S., a primigravida, had a sudden severe attack of pain and tenderness in the right iliac fossa, in the 16th. week. A pyelogram taken at this stage 7 minutes after uroselectan — Fig. 92 — shows delay in excretion at the right side. At 30 minutes after injection there was no shadow of the right ureter but in a plate taken 50 minutes after injection, Fig. 93, the right ureter showed, dilated slightly but narrowed to a point at the level of the pelvic brim. A ureteral catheter passed up the ureter was obstructed at 13 cms. but was eventually manipulated beyond this point with immediate relief of the pain and tenderness in the right iliac fossa. The pain was due to a spasm of the ureter at the pelvic brim induced probably by the pressure of the pregnant uterus.

Mrs. G., a VI-para, previously healthy, at the beginning of the seventh month of pregnancy developed

sudden severe pain in the left kidney region. An intravenous pyelogram in Fig. 94, taken 7 minutes after injection, shows the right renal tract down to the level of the pelvic brim. The left calyces and kidney pelvis are all that show of the left tract as yet. A spasm of the left ureteropelvic junction occurred in this case and the pain was again relieved by the passage of a ureteral catheter to a point above the pelvic brim.

The following case demonstrates the value of ureteral catheterisation in the differential diagnosis of chronic appendicitis and ureteral spasm in pregnancy.

Mrs. L., a multipara, had been under observation for some time before the pregnancy and had been in hospital with a diagnosis of chronic appendicitis. During the pregnancy the pain had become much worse and was extremely severe in the right iliac fossa and to a less degree in the right kidney region. An intravenous pyelogram, Fig. 95, taken 7 minutes after uroselectan, showed both renal tracts clearly down to the level of the pelvic brim. On the left side there is no dilatation and on the right there is an acute kink of the ureter where it leaves the pelvis of the kidney and another acute kink at the pelvic brim. The passage of a ureteral catheter to a point above the pelvic brim again gave relief in a most dramatic fashion.

Summary.

Dilatation of the upper urinary tract occurs in nearly every pregnant woman, although a few go through the whole course of pregnancy without any. On the right side the dilatation is usually more marked and affects the calyces, kidney pelvis and ureter down to the level of the pelvic brim, where the ureter narrows suddenly. In its pelvic portion the right ureter is undilated. On the left side the calyces and kidney pelvis are less frequently involved,

the dilatation affecting the ureter usually throughout its whole course, tapering gradually to the bladder, but in some cases narrowing abruptly at the pelvic brim.

On both sides kinks are usually seen but on the right they are much more pronounced and may be very acute. They are usually situated at the junction of the kidney pelvis and ureter and cause definite narrowing of the lumen.

Lateral displacement of both ureters to the outer border of the psoas muscle frequently occurs in the second half of pregnancy, and when this occurs the ureter escapes compression until it crosses the psoas muscle at the level of the pelvic brim to gain access to the pelvis. This is demonstrated in Fig.65. In other cases where no lateral displacement occurs, the ureter lying along the psoas muscle is compressed for a greater part of its course, above the brim of the pelvis. This is shown in Fig.55. Where the abdomen is pendulous, in primigravidae due to contracted pelvis or spinal deformity and in multiparae due to a lax abdominal wall, the point of compression is usually low, at the pelvic brim, but where the abdominal muscles are firm and the ureter not displaced laterally, it is flattened in its abdominal portion to a much higher level. Dilatation

of the upper urinary tract is more marked in primigravidae than in multiparae. Dilatation is found as early as the tenth week and at this stage is uniform throughout both ureters involving the pelvic as well as the abdominal portions, probably due to a general atony as the result of the pregnant state. There are indications, however, that dilatation may be more marked on the right side even at this early stage, as is shown in Fig.70. At the end of the fourth month the dilatation is increased by the pressure of the pregnant uterus and this is more marked on the right side. Till the sixth month dilatation increases but from then until full time it decreases on the left side and on the right side one of several things may happen. The calyces, kidney pelvis and ureter down to the pelvic brim may dilate further, or they may diminish in size. More commonly the calyces and kidney pelvis increase in size and the ureter diminishes.

In conjunction with dilatation, stasis is usually found although dilatation can exist without stasis and stasis may be present with very little dilatation. Stasis begins early in pregnancy, reaches its maximum as a rule at the sixth month and diminishes near full time. On the

right side as with dilatation, the stasis, which at the sixth month is greatest in the ureter, becomes greater in the kidney pelvis and calyces near full time, while the elimination from the ureter has improved. The effect of the changes on kidney function differs therefore at various stages of pregnancy. At the sixth month, although there is marked disturbance of ureteral function, the kidney function may be better than later when the function of the ureter has improved, as owing to the increased pressure of the uterus and the improved tone of the ureter the intra-ureteric pressure rises and adversely affects kidney function. This explains why at the sixth month dense shadows of the urinary tract are obtained in intravenous pyelograms, as there is the optimum combination of good excretion by the kidney and delay in emptying the ureter, whereas in the later months, the kidney excretion is relatively poor and there is less stasis in the ureter, so that the shadows obtained are less dense. The difference in density of the shadows obtained at those two stages of pregnancy is too great to be explained by the increase in size of the uterus obscuring the picture.

As the effect on the left kidney is almost

negligible symptoms of kidney deficiency seldom develop during pregnancy. In 15 per cent. pain referable to the urinary tract occurs, due to upset of ureteral peristalsis.

As regards the causal factors, it is certain that the uterus can compress the ureters against the psoas muscle at the pelvic brim and for some distance above that point, depending on the course of the ureter. I have brought much evidence to support this.

Some other factor must play a part as the dilatation produced during pregnancy is much greater than that found with ovarian cysts of similar size and situation in the non-pregnant. I have shown that diminution in tone occurs very early in pregnancy and accounts for the dilatation which occurs before pressure of the uterus can be a factor. It also accounts for the marked degree of dilatation and stasis which results from the comparatively slight pressure of the uterus on the ureter at the pelvic brim in the fifth and sixth months. Histological examination of the wall of the ureter above the point of compression has shown that no hypertrophy occurs in response to the obstruction but, because of the atony, the ureter simply stretches. Dilatation and stasis would be progressive till

the end of pregnancy due to the increasing pressure of the uterus, if some other factor did not come into play. As I have shown, however, the tone of the ureter improves near full time, but diminishes rapidly in the puerperium especially in those cases where the dilatation and stretching reach a high degree. Where the dilatation is only slight during pregnancy the falling off in tone in the puerperium is much less. This suggests very strongly that the improvement in the cases with marked dilatation is due to an external stimulus, which is suddenly withdrawn after labour. The ureters subsequently regain their tone slowly, in proportion to the rate of disappearance of the dilatation. In some cases where it has been very great, the urinary tract never returns to normal and the tone remains less than that of the left ureter which has been relatively unaffected. It seems likely that the substance which stimulates the ureter towards the end of pregnancy may be the hormone of the posterior pituitary lobe. I have shown how an injection of this substance in the puerperium will raise the tone of the ureters within a few minutes. It may, however, be that the explanation is much less simple.

It has been shown by Robson (1933) and others that the activity of the uterus, as judged by response to pituitrin, varies at different stages of pregnancy. It is practically insensitive to pituitrin until the sixth month of pregnancy, from which time until full time it becomes increasingly more sensitive to small doses. Within a few days of delivery it is again insensitive to it. These variations correspond in time to the variations in the activity of the ureter as determined by the various methods described, since we have shown that the ureters are most inactive at the end of the sixth month and that their activity improves steadily towards full time. In the puerperium they again become less active. In patients suffering from albuminuric toxæmia there is excess of posterior pituitary hormone in the circulation (Anselmino, Hoffmann and Kennedy, 1932) and in these cases we know that there is very little atony of the ureters. This also suggests that the posterior pituitary hormone may be responsible.

Discussion.

The incidence of dilatation of the urinary tract has been thoroughly investigated and most workers are agreed that some dilatation occurs in over 80 per cent. of pregnant women. Schumacher (1930) finds dilatation in all of 100 cases examined by pyelography, 83 per cent. on both sides, 15 per cent. on the right alone and 2 per cent. on the left alone. In 1932, as the result of 450 pyelograms, he states that the abdominal portion of the ureter is 1 cm. broad in 75 per cent. of cases and 1.5 to 2 cms. broad in 30 per cent. of cases. Similar figures have been published by Kretschmer and Heaney (1925), Luchs (1927), Gremme (1931) and Cornell and Warfield (1933). Saitz (1931) finds dilatation in 84 per cent. of cases. The incidence of dilatation may possibly vary with the type of patient and, in view of this, Strumpf (1933) has selected a series of 50 healthy primigravidae and finds deviation from the normal in 46 or 92 per cent. This corresponds to my finding that occasionally no dilatation of the urinary tracts occurs. He also differentiates between dilatation of the ureter and dilatation of the calyces and kidney pelvis. He finds that the major calyces are dilated in 88 per cent. on the right side and in 46 per cent. on the

left, while changes in the ureter occur in 78 per cent. on the right side and 60 per cent. on the left. Duncan and Seng (1928), by means of catheter pyelograms, find that the kidney pelvis is more often affected on the right side than on the left. Those workers do not, however, attempt any explanation of the difference on the two sides.

According to Schumacher, kinking of the ureter occurs in all cases, in 80 per cent. just below the kidney pelvis and in 20 per cent. at the junction of the upper and middle thirds of the ureter. He also finds that the kinks do not cause obstruction. He does not record the narrowing of the lumen at the apex of the kink which I have described. In my opinion, this kinking is another evidence of obstruction at the pelvic brim, as Vermooten (1930) has shown that tortuosity and kinking precede dilatation of the ureter after partial ligation in dogs, where gravity is not a factor. Kamniker (1928) is of the opinion that the kinking of the ureter is due to increased vascularity of the peri-ureteral tissue which makes it more movable and Saitz (1931) believes that it is partly due to ptosis of the kidney and partly to lengthening of the longitudinal muscle fibres which he believes occurs as the result of pregnancy. Marked

kinks of the kidney can be seen, however, where the kidney is in normal position.

Very few workers refer to the important fact that dilatation is more marked in primigravidae than in multiparae. Crabtree and Prather (1931) find that dilatation is more marked in first and second pregnancies than in subsequent pregnancies. Contrary to my findings, Friedl (1933) states that there is no difference between primigravidae and multiparae, and Guthmann and Ehrhardt (1931) and also Duncan and Seng (1928) find that dilatation is greater in multiparae than in primigravidae. Their numbers are too small on which to base conclusions.

There is very little in the literature about the time of onset of dilatation or what happens to it as pregnancy advances. This is largely because no investigation at frequent intervals during the course of pregnancy has been made on a large scale. Duncan and Seng (1928) performed retrograde pyelography at intervals during pregnancy but not repeated in the same patient. They found dilatation of the ureters at the sixth week of pregnancy in multiparae and in the tenth week in primigravidae, and in their opinion dilatation reaches its maximum at the 22nd.

week in multiparae and the 24th. week in primigravidae. Those conclusions as to the period of maximum dilatation are not justified, as the observations were not repeated in the same patients. I have shown that the time of maximum dilatation is variable. Kretschmer and co-workers (1933) examined patients on two occasions during pregnancy between the second and the fifth months and between the sixth and the ninth months. They found dilatation from the second to the fifth month in 67 per cent. of cases, and from the sixth to the ninth month in 93 per cent. and conclude that the dilatation is progressive. This conclusion is not justified as two examinations are not nearly enough to follow the changes which occur as pregnancy advances. Gremme examined six cases between the end of the second and the end of the fourth month and found no dilatation or delay in excretion in any of them. He concludes that dilatation does not begin till after this period. As he did not examine these six cases later in the pregnancy they may have been of the type which never have much dilatation or delay, and such a small number does not justify any conclusions. Penkert (1933) and Hale White (1912) both state that the pressure exerted by the pregnant uterus is greatest at the sixth

month, as after that the uterus ascends into the abdomen and the narrow lower pole is over the pelvic brim, so that pressure is less.

Schumacher (1932), Sennewald (1928) and numerous other continental workers draw attention to the fact that renal pain occurs frequently in association with those changes of pregnancy and Schumacher has pointed out that pyelograms are often of little value in diagnosing whether the pain is of renal origin or not. He stresses the importance of passing a ureteral catheter in such cases but states that the catheter should always be passed above the obstruction, which in his opinion is at the acute kink. This would be not only impossible in some cases but would run the risk of perforating the ureter as these kinks are very acute. As I have shown earlier, this is quite unnecessary.

Gremme (1931) came to the important conclusion that dilatation could occur without stasis and that delay in emptying the urinary tract could occur without the kidney function being affected. The conclusions about kidney function are not based on the urea concentration test but on the indigo carmine findings alone. Kammiker (1928) found that atony and stasis were present before anatomical changes

in pyelograms could be demonstrated, whereas Goldstein (1921) found that stasis did not appear until the 20th. week. Guthmann and Ehrhardt (1931) also found dilatation without stasis. There is very little detail as to variations in kidney function on the two sides.

Most workers now believe that the ureters are obstructed in the neighbourhood of the pelvic brim. Some say that the compression is between the psoas muscle and the uterus (Schumacher and Friedl), and others that it is between the uterus and the pelvic brim (Simon and Navratil, (1931), Sennewald, who also states that it may sometimes be between the uterus and the common iliac artery, and Kretschmer and co-workers). The evidence in favour of pressure of the uterus is overwhelming, for many reasons. (1) Post-mortem examination shows dilatation and kinking of the right ureter above the pelvic brim and narrowing below. (2) Intravenous pyelography shows similar deformity of the right urinary tract in the living. As has been pointed out, the lower half of the right ureter cannot be demonstrated by this method and the obstructed part above the pelvic brim, where there is no shadow in the pyelogram, is exactly the shape and size of the segment of the psoas muscle in this area and

runs in the same direction as the psoas muscle. (3) Those characteristic changes in the right ureter only appear from the end of the fourth month, when the uterus reaches to the level of the pelvic brim, and placing the patient in the hands and knees position at this stage of pregnancy relieves the obstruction to outflow by allowing the uterus to fall forward. (4) A ureteral catheter passed up the right ureter meets with a soft obstruction at the level of the pelvic brim. (5) Sodium iodide injected through a catheter into the lower half of the ureter will give a shadow only up to the level of the pelvic brim whereas in the non-pregnant a satisfactory shadow of the whole urinary tract is obtained. (6) The passage of a catheter to a point above the pelvic brim will drain off stagnant urine in large quantities whereas when the catheter is pulled below the pelvic brim, drainage suddenly ceases. (7) Tumours in the non-pregnant patient can cause obstruction to the ureter at the same point and the fact that the right ureter in those cases is more liable to dilatation also suggests that the difference on the two sides is the result of the more exposed course of the right ureter. (8) The rapid disappearance of the stasis in the puerperium when the uterus has become a pelvic organ

again points to the relief of pressure.

On the other hand, many workers deny the possibility. Hofbauer (1928) is of the opinion that the obstruction to outflow is in the juxtavesical portion of the ureters, due to the hypertrophy which he has described, and explains the difference on the two sides by the dextro-rotation of the uterus kinking the lower end of the right ureter. Gremme and Schumacher, however, find that in the second half of pregnancy there is no obstruction to outflow in the juxtavesical portion, although the bladder is distorted. De Lee states in his textbook of obstetrics that the specific gravity of the uterus is the same as that of the other internal organs and that it cannot therefore cause pressure on the ureters. Strumpf believes that the involution of the changes in the puerperium is too rapid for the cause to be mechanical. Lee and Mengert (1934) are of the same opinion for the same reason, but their estimate of the rate of involution of the changes is incorrect as they rely upon intravenous pyelography which, as we have shown, is unsatisfactory in the puerperium.

Strumpf believes that the tension of the abdominal wall has no effect on the incidence of dilatation but he

distinguishes only between presence or absence of dilatation and takes no account of degree of dilatation. As only 4 out of 50 cases examined had no dilatation, it is difficult to see how Strumpf draws any conclusions about the tension of the abdominal wall.

It is generally held that the position of the foetus has no influence on the occurrence of dilatation but Mahon and Guichard (1931) state that the foetal shoulder is the cause of the compression.

Many workers, notably Sellheim and Stoeckel (1925), believe that the changes produced in pregnancy are the result of the pregnant state and analogous to the general relaxation of all hollow organs which occurs during pregnancy. While this atony undoubtedly exists, it is not the only factor, although probably the chief predisposing one. Vaudescal and his co-workers (1927) consider atony to be a factor. They find a lack of sensitiveness of the urinary tract by pyeloscopy which shows diminished motility from the sixth month onwards, especially on the right side. Schumacher (1932) has also tested the tone of the ureters by blocking the lower end with a dilatable ureteral catheter. He finds that in the non-pregnant the first sensation of pain due to

distension occurs in from 10 to 12 minutes and the ureter is dilated from 4 to 6 mms. In pregnancy no sensation occurs for 20 to 30 minutes and in most there is none at 30 minutes. Meanwhile the abdominal ureter is dilated to 16 mms. He makes no observations about what happens to the tone at various stages of pregnancy.

Attempts have been made to explain this atony by over-activity of the vagus which, according to Penkert (1933), is dependent on the relative proportion of potassium and calcium ions in the blood. He quotes the results of various biochemists and comes to the conclusion that the disturbance of tone during pregnancy is due to an upset of the 'K-Ca Quotient', increase of potassium causing over-excitability of the vagus or parasympathetic and decrease of calcium diminishing the excitability of the sympathetic, so that there is relaxation of all the hollow organs and a condition of hypotonus exists. This overexcitability of the parasympathetic in pregnancy has been confirmed by Muck (1925) by means of the A.S.V., a test of the response of the nasal mucosa to adrenalin. He found the test positive in 80 per cent. of women in the early stages of pregnancy but by the end of pregnancy in only 18 per cent.

A negative result indicates overaction of the parasympathetic. In hyperemesis gravidarum he found a negative result much more frequently in the early months. Höglér (1933) repeated Muck's investigation, using the response of the bladder mucosa to adrenalin, and confirmed his results.

Schmidt (1928), Lee and Mengert (1934) and Strumpf (1933) all agree that the dilatation disappears almost at once in the puerperium and argue that it cannot therefore be due to mechanical obstruction. Kamniker (1928) states that the stasis and dilatation disappear usually within 14 days of the delivery. Jacobi (1932) finds that by the end of four weeks postpartum no changes are recognisable but, in a later paper in the same year, he says that hypotone exists for a long time after the ureters have returned functionally to normal. Simon and Navratil (1931) hold that the recovery in the puerperium is slow and that dilatation and atony are found a year after delivery. Friedl, Brakemann (1930) and Vandescall all believe that involution in the puerperium is slow but do not mention stasis.

In conclusion, it appears that there are two causal factors of the changes occurring in the urinary tract in pregnancy — atony of the ureter and compression by the

pressure of the pregnant uterus, the first facilitating the second. The atony is part of the general reaction of the organism to the pregnant state and its true nature will only be understood by further investigation of the endocrinology and biochemistry of pregnancy.

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CHAPTER IV.INFECTION OF THE URINARY TRACT DURING PREGNANCY.

I. Bacteriology.

(a) Methods.

(b) Importance of careful bacteriological examination of the urine during pregnancy and comparison of various methods.

(c) Findings.

II. Incidence of infection of the urine during pregnancy.

(a) In healthy pregnant women with no previous urinary infection.

(b) In a series of 1779 consecutive cases admitted to the antenatal wards of a maternity hospital.

III. Clinical Significance of pyuria and bacteriuria in pregnancy.

IV. Pyelitis of pregnancy.

Etiology.

- (a) Incidence.
- (b) Predisposing factors.
- (c) Infecting organism.
- (d) Mode of origin.

Pathology.

Urological Findings.

Signs and Symptoms.

Diagnosis.

Course of disease.

Prognosis.

Treatment.

After results.

Bibliography.

Infection of the urinary tract is very common in pregnancy, and although pyelitis of pregnancy is a well recognised clinical entity, atypical forms of pyelitis and minor degrees of infection go undiagnosed and untreated. A symptomless urinary infection may be responsible for an obscure toxæmia of pregnancy. Although the acute symptoms in pyelitis of pregnancy usually disappear with simple treatment, the end-results both as regards the child and the mother are often unsatisfactory. The child is frequently born prematurely and the mother may have a persistent chronic urinary infection with consequent ill health and even a degree of permanent kidney damage. In the following investigation on large numbers of pregnant women I have attempted to determine accurately the incidence and importance of the various degrees of urinary infection, to explain the variety of clinical symptoms, to provide more efficient treatment and to gain information about the end-results and the prognosis for future pregnancies.

I. BACTERIOLOGY.

(a) Methods.

Urine. A catheter specimen of urine is taken in the morning, so that it can be examined as soon as possible, usually within 2 hours. This is of great importance in estimating the severity of the infection, as if left for any length of time, proliferation of the organisms occurs very rapidly and any contaminating organisms also multiply. So long as the urethra is well exposed so that the catheter can be passed directly into it, cleansing of the skin is, in my opinion, unimportant. I have taken off specimens of urine through a cystoscope in a series of 100 out-patients as often as 7 or 8 times during the pregnancy; the only part cleansed was the urethral orifice with a swab soaked in 1/1000 biniodide of mercury solution and no contamination or urinary infection as a direct result of the instrumentation occurred in any of them.

The risk of catheterisation during pregnancy, if carefully done, is very slight. This is also the experience of Day (1925), Kincaid (1928) and Dodds (1931), but Curtis (1923) and Williams (1926) think that no matter how carefully it is performed, catheterisation will lead to infection of the urinary tract. Curtis has stated that this is due to the frequency of residual urine in the bladder in pregnancy but in my experience there is very seldom any residual urine in the bladder during pregnancy. In passing it may be noted that conditions in the puerperium

are very different, as there is frequently residual urine in the bladder and the risk of catheterisation greater.

A fresh drop of uncentrifuged urine is then examined under the high power lens of the microscope. The number of pus cells and organisms in a single field is counted and on this basis the estimate of the severity of the infection is made. Presence of red blood corpuscles and casts of various kinds is noted. Some of the urine is centrifuged and films made of the deposit and stained by Gram's method. The presence of pus cells and various types of organisms are noted under oil immersion. The supernatant fluid is examined for the presence of albumen and the reaction of the urine to litmus paper tested. Cultures are made from the uncentrifuged urine on blood agar plates and MacConkey's solid medium. This procedure was adopted after comparing a series of cultures made with centrifuged urine as better separation of the different types of organisms was obtained with the uncentrifuged specimen. Cultures were incubated for 24 hours and the various types of colony identified.

Vaginal Discharge. When required, specimens of vaginal secretion are taken on swabs through a speculum and are inoculated on to solid medium, blood agar and MacConkey plates. A direct smear of the secretion is made and stained by Gram's method.

Faeces. MacConkey's medium only is inoculated.

Blood. 60 ccs. of Hartley's broth are inoculated with 5 ccs. of blood and incubated for 48 hours. Films are made from the surface of the sedimented blood at the bottom of the broth. Where organisms are seen they are subcultured on a blood plate.

In all cases the plates are kept for several days to observe any changes which may develop in the colonies. This is especially useful in MacConkey

plates where several types of coliform organisms are present, as the different characteristics of the different types of colony become more apparent after several days. At the beginning of the investigation, several colonies were picked off from each MacConkey plate, although they looked similar. They were however found to be identical, so that now only colonies differing in appearance are subcultured. The various coliform organisms are identified by their properties, such as sugar reactions, formation of indol, motility, Voges-Proskauer reaction and gelatin liquefaction. In certain cases the coliform organisms obtained from the urine, vagina, blood and faeces are compared and their identity further tested by serological reactions. If the patient's serum is found to agglutinate one of the organisms cultured, it is used in the agglutination tests, but if not, an antiserum is prepared by inoculating a rabbit with a killed culture of one of the organisms. No difficulty was experienced in producing agglutinins in the rabbit's serum, as in most cases only four or five doses were required.

Where the organism is not one of the coliform group, steps are taken to identify it sufficiently to place it in one of the broad categories, e.g. in cases of streptococci, broth culture to test the chaining properties, heat and haemolysis tests and sugar reactions.

(b) Importance of careful bacteriological examination of urine during pregnancy and comparison of the various methods.

1,000 cases admitted to the antenatal wards of the Maternity Hospital have been investigated to compare the findings in the urine obtained by the nurses in the

wards and by myself in the laboratory. One half of the catheter specimen of urine taken in the morning was examined by the nurses and the other half in the laboratory. The results of the test for albumen show a marked disparity, and the details are set out in Table I.

T A B L E I.

	Lab. + Nurses +	Lab. - Nurses -	Lab. + Nurses -	Lab. - Nurses +	Lab. + No Nurses' Test	Lab. - No Nurses' Test
(1) Urine sterile	49	129	10	30	37	261
(2) Slight infection (no clinical significance)	7	35	5	9	48	63
(3) Infection of doubtful significance	7	23	4	5	23	39
(4) Pyelitis	69	31	21	20	7	8

The cases are divided into four groups, according to whether (1) the urine is sterile, (2) slightly infected (of no clinical significance), (3) slightly infected (of doubtful clinical significance) or (4) heavily infected (pyelitis). + in the table indicates that albumen is present according to the heat test, and - that it is absent. The disparity between the nurses' and the laboratory

findings is 18·2 per cent. in group 1, 25 per cent. in group 2, 23 per cent. in group 3 and 29 per cent. in group 4. In some cases the nurses' test is positive when the laboratory test is negative and in others the reverse is the case. This is probably due to the fact that where the urine is opaque before the heat test is performed, it is impossible to detect a faint haze of albumen or, as is more common, the opacity of the urine is increased by boiling due to the effect of heat on the pus cells and organisms in suspension. As one would expect, the latter error is more frequently made in cases where there is fairly heavy infection. This explains in some measure why many cases on the strength of finding this increased opacity of the urine on boiling are diagnosed as mild albuminuric toxæmia, when the condition is really due to pyuria. The urine should therefore be made clear by centrifugalisation or filtration before testing for albumen.

We may note here that the incidence of albuminuria in the series, according to the laboratory test, was 34·7 per cent. and in the pyelitis group 62·1 per cent.

The results of the chemical test for pus as performed by the nurses were compared with the microscopic

findings. In groups 1, 2 and 3, where the amount of pus is small, the chemical test seldom gives a positive reaction, but even in group 4, the cases of pyelitis, the chemical test failed to detect pus in 57 per cent. It is evident therefore that the only reliable test for pus in the urine is the microscopic test. This is emphasised by Dukes (1928) who has devised a special slide for counting the number of leucocytes in the urine. He states that the finding of 100 leucocytes per cc. points to disease of the urinary tract and that the significance of 50 to 100 per cc. can only be decided by urological examination: 400 leucocytes per cc. are necessary before a clear urine becomes turbid to the naked eye and the guaiac and liquor potassae tests are often negative in urine containing 500 leucocytes per cc.

The relative value of the four laboratory methods for detecting infection of the urine, namely, examination of a fresh drop (F.D.), examination of a stained film from a centrifugalised deposit (C.F.), culture on blood agar plate from uncentrifugalised urine and culture from centrifugalised urine has been investigated. From Table II we see that in group 4 (pyelitis cases), infection is

diagnosed by examination of a fresh drop (F.D.) in 100 per cent. of cases, that is, the fresh drop and culture findings were both positive in all cases. In this group the pus cells are not always abundant, for even in severe cases of pyelitis after the acute symptoms have passed off, very few pus cells may be seen although organisms are abundant. In acute cases, therefore, the number of pus cells is an index of the severity of the infection but in more chronic cases, the number of organisms present is a more reliable guide. In pregnancy the infecting organism is nearly always a coliform bacillus, which is easily seen by this fresh drop method.

TABLE II.

	F. D.			
	D.F. -ive C. -ive	D.F. +ive C. +ive	D.F. -ive C. +ive	D.F. +ive C. -ive
(1) Sterile	92.3%	0%	7.7%	0%
(2) Infection of no significance	27.1%	32.9%	37.0%	3%
(3) Infection of doubtful significance	1.8%	72.7%	23.6%	1.8%
(4) Pyelitis	0%	100%	0%	0%

	C. F.			
	C.F. +ive C. +ive	C.F. +ive C. -ive	C.F. -ive C. +ive	C.F. -ive C. -ive
(1) Sterile	0%	16.6%	4.1%	79.3%
(2) Infection of no significance	16.6%	26.1%	4.7%	0%
(3) Infection of doubtful significance	63.9%	3.7%	0%	0%
(4) Pyelitis	100%	0%	0%	0%

Table II shows that in 7.7 per cent. of cases, classified as having sterile urine, in whom the fresh drop examination was negative, the culture was positive, usually due to staphylococci. The positive results on culture are due to contamination, as they are not constantly found on re-examination of the urine. An erroneous idea of the

frequency of infection may thus be obtained from the results of culture alone. With the centrifugalised film the same thing is seen, as in 4.1 per cent. of cases where the examination of the centrifugalised film was negative, the culture was positive, due to contamination. On the other hand, the examination of a centrifugalised film gave a positive result where the culture was negative in 16.6 per cent. Some of the organisms were Gram-negative, resembling coliform bacilli, and the explanation of their failure to grow on culture may be that they were in a devitalised or dead state. In other cases the organisms were slender Gram-positive or Gram-negative bacilli, seen round about or inside large epithelial cells. These are not likely to be due to contamination from the vagina as they were constantly found in certain cases examined repeatedly, while in others there was no sign of them at any time. In the groups 2 and 3, where the infection was of doubtful or no significance, examination of the fresh drop was negative in 23.6 per cent. and 37 per cent. respectively, while the culture was positive. As regards the examination of the centrifugalised film, this was positive in 3.7 per cent. and 26.1 per cent. respectively where the culture was negative. It is

clear therefore that the presence of organisms in the urine is more often detected by the examination of the centrifug-alised deposit than by any other method.

In the pyelitis group, the examination of the fresh drop was positive in 100 per cent. of cases, in the doubtful significance group positive in 72·7 per cent. of cases and in the no significance group positive in 36 per cent. of cases, so that if the infection is so slight as not to be apparent in the examination of the fresh drop, it has no bearing on the condition for which the patient has been admitted to hospital and if the centrifugalised film or the culture findings are relied upon, the incidence of significant infection will be greatly over-estimated. Dodds (1931) emphasises the importance of the examination of the uncentrifugalised drop of urine from a fresh catheter specimen in making a diagnosis of inflammation of the urinary tract. She states that organisms are found more readily on culture than by examination of the fresh drop or centrifugalised film. This does not agree with my findings. Dodds states that "if organisms are found on microscopic examination of the uncentrifugalised drop, even although pus cells are only found in the centrifugalised-

ed drop, an inflammation of the urinary tract may ensue." In my experience such a finding indicates the chronic stage of an inflammation which has been acute, not the preliminary to inflammation.

(c) Findings.

TABLE III.

Type of case	Coli alone	Coli and other organisms	Staphylococci and Streptococci	Unclassified	Pus only
Pyelitis	137-87.8%	10	7	1	1
Doubtful pyelitis	63-62.3%	19	10	4	5
No significance	45-27%	12	38-22.7%	46-27%	26

Table III shows the types of organisms found in the 425 infected cases in the series of 1,000 cases admitted to the antenatal wards. Coliform organisms were found in 94.2 per cent. of the pyelitis cases and occurred alone in 87.8 per cent. of these. Where the coliform organism was associated with other organisms the infection was usually chronic. Where the infection was due to staphylococci or to

streptococci, it was mild and yielded quickly to treatment. In the acute cases coliform organisms were found alone in practically all. In the group where the significance of the infection was doubtful, coliform organisms occurred alone in only 62·3 per cent., and in the third group, where the urinary infection was of no significance, coliform organisms were found alone in only 27 per cent. of cases.

In those cases of the pyelitis group where coliform organisms were associated with other organisms in the centrifuged film, the latter were cocci and lanceolate Gram-positive organisms, often in pairs, but were not identified as they did not grow on culture. It seems unlikely that they were of any importance.

Of the 7 cases in the pyelitis group where cocci alone were found, 4 were due to Staphylococcus albus, 2 to Staphylococcus aureus and 1 to Staphylococcus albus and diphtheroids. They were all chronic cases, except one due to Staphylococcus aureus, where acute infection of the urinary tract followed a mastoid operation in the fifth month of pregnancy. The same organism was isolated from the pus in the ear in this case. Where the infection was acute, only one type of coliform organism was isolated from

the urine in 91.9 per cent. of the cases examined, as shown in Table IV.

TABLE IV.

Group	Number of cases typed	One type only	Two types	Three types
Pyelitis	99	91 - 91.9%	7 - 7%	1 - 1%
Infection of doubtful significance	27	23 - 85%	4 - 15%	0
Infection of no significance	13	7 - 52%	5 - 38%	1 - 10%

In the more chronic cases and in the groups of doubtful or no significance, more than one type of coliform organism were frequently found. The tests used included the reaction on five sugars, glucose, lactose, saccharose, mannite and dulcitol, motility, indol formation, action on litmus milk, and in certain cases the Voges-Proskauer reaction and the power of liquefying gelatin. The types found were:-

(1) B. coli communior in 34.

(2) B. acidilactici in 36.

(3) B. coli communis in 35.

(4) In 19, all the sugars were fermented, with the exception of dulcitol. Indol was formed in all but 3, in whom also the Voges-Proskauer reaction was positive. Those 3 give the reactions of B. lactis aerogenes, while the remaining 16 correspond to B. neapolitanis group.

(5) In 14, acid but no gas was produced in various sugars. Sometimes all the sugars were fermented, suggesting B. coli anaerogenes. In others, all but lactose or saccharose were fermented. None of these organisms belong to the typhoid or dysentery groups and they all formed indol. In every case the organism was subcultured repeatedly and sugar reactions repeated at intervals varying from a few months to two years, usually with identical results, although in 2 cases gas formation did occur eventually in all sugars.

(6) In 10, the organisms did not ferment lactose and belonged to the paracolon group. Two gave reactions corresponding to those of Morgan no. 1.

In 23 out of 95 cases in which the power of haemolysis was tested, the organism was haemolytic to varying degrees, but this property was not associated with any particular type of coliform organism and the patients were not more seriously ill than those in whom the infecting organism was non-haemolytic. In the haemolytic group, 20 per cent. were classified as seriously ill and in the non-haemolytic group, 28 per cent. Table V shows that the severity of the illness does not depend on the type of infecting organism except perhaps in the case of type 4 where the percentage of very ill patients was 42.1 as against 25 per cent. for the rest of the series.

TABLE V.

Severity of Illness	Type of Infecting Organism					
	1	2	3	4	5	6
Very acute	10-29.4%	9-25%	7-20%	8-42.1%	2-14.3%	1-10%
Moderate	16	12	8	7	4	5
Slight	8	15	20	4	8	4

The less common types of coliform organisms were associated with less severe types of illness. They were very often found in chronic cases, usually in association with other coliform organisms. In a series of 48 pregnant women examined by Dodds (1931) the same variety of coliform organisms was seen, except that there were none which did not ferment lactose. Frank (1931) found that the commonest organisms in pyuria in infancy were B. neapolitanis, B. coli communior and B. coli communis. He found the same organisms in the vagina and bowel of healthy infants, most frequently when the diet is rich in starch. Hill and co-workers (1929) found coliform organisms of the aerogenes and cloacae types (Voges-Proskauer reaction positive and no indol formation) in 79 of 200 cases of urinary infection but out of 6979 cultures of colon bacilli from faeces they found those types present in only 3.96 per cent. They were found commonly in the blood. They conclude that these organisms are more resistant to changes of environment than other types of coliform organisms. This has not been my experience, as I have found organisms of the aerogenes group only occasionally in either the blood stream or the urine. They also found haemolytic types of coliform

organisms in 60 per cent. of cases, much more often than was the case in my series.

In 69 cases of pyelitis, the power of the patient's serum to agglutinate the organism found in the urine has been investigated. The formation of agglutinins was not associated with the presence of any particular type of organism in the urine. The power of the serum to agglutinate the organisms was found as often in mild cases as in severe.

T A B L E VI.

Severity of Illness	Agglutination	No Agglutination
Very acute	9 30%	13 34%
Moderate	13	14
Slight	8 26.6%	12 31.6%
Total	30	39

Table VI shows that out of 69 cases tested, agglutination occurred in 30, and in most of those it occurred up to a very high titre (1/2,000). Two control organisms were used in each case, one giving different sugar reactions and

the other giving the same as the one in the urine and in all cases the agglutination was found to be specific for the organism in the urine, which proves it to be the causal organism in the illness. Several cases were retested for agglutination some months after the end of pregnancy and it was found that no agglutination now occurred. The presence or absence of agglutinins in the acute attack was no indication of the prognosis.

II. INCIDENCE OF INFECTION OF THE URINE DURING PREGNANCY.

(a) In healthy pregnant women with no previous urinary infection.

The risk of urinary infection developing during pregnancy is difficult to assess. It means repeated bacteriological examination of the urine during the course of pregnancy in women previously healthy. This is difficult to do at an out-patients' dispensary as should an acute attack or other illness develop, the patient would be unable to attend. Further, women seldom come for advice before the fifth month of pregnancy unless they are ill, so that

there are very few normal healthy pregnant women available in the early months of pregnancy for investigation. I have examined the urine at monthly intervals in 205 women who reported before the end of the third month of pregnancy. In all, 624 specimens were examined, and the following is an analysis of the findings. In the urine at one time or other during the pregnancy there were found —

pus cells and organisms in 51 cases,	24.8%
pus cells only " 29 "	13.6%
organisms only " 9 "	4.6%.

117 cases or 57% were negative throughout.

If we analyse, first of all, the cases where the urine was sterile at the first visit — 149 — we find that 53 of those did not report again for various reasons, and although we know that 31 of them did not develop pyelitis clinically, we cannot say whether microscopically they ever did have urinary infection. We do not know whether pyelitis developed in any of the 22 cases who could not be traced, and this must be borne in mind when we consider the incidence of pyelitis in those cases who were examined repeatedly, since they represent only those who remain relatively well. 96 cases remain in which the urine was

sterile at the first visit and in which a catheter specimen was examined at monthly intervals throughout the pregnancy: there were found —

pus cells and organisms (at 4-6 months) in 12 cases

" " " " (at 8 months) " 2 "

14 " or 14.5%

organisms only " 7 "

pus cells only " 11 " .

In 64 the urine was negative throughout.

There are only 18 primigravidae in the series of 96 cases, and 5 of the 18 developed infection during the pregnancy — 27 per cent., as compared with 11 per cent. of the multiparae. This comparison is of little value, however, as the number of primigravidae is too small.

It is impossible to tell without a complete urological examination, and even then it would be difficult if the infection was slight, whether the infection was coming from the bladder or the upper urinary tract.

Heavy infection was present in only one case, in which miscarriage occurred at the sixth month due to pyelitis of pregnancy. In all the others the infection was slight and usually intermittent. In 6 the symptoms

suggested mild pyelitis and in 3 cystitis. Therefore, as diagnosed clinically, pyelitis developed in 7.3 per cent. of cases. Although pain referable to the upper urinary tract was present in some cases (24 per cent.) where the urine remained sterile throughout the pregnancy, the incidence of urinary symptoms was much higher (64 per cent.) in the cases which developed slight urinary infection, indicating that the infection is probably of some significance.

To obtain further information on the subject, 84 cases have been analysed in which a complete urological examination was performed at monthly intervals during the course of the pregnancy. In all cases the urine was sterile at the first visit. In 43 cases stasis of urine occurred in one or both ureters during the pregnancy, and in 5 cases pyelitis developed as a sequel to the stasis. In 41 cases there was little or no stasis, in 1 of which pyelitis developed and cystitis in 2. The case of pyelitis in this group was mild and followed the development of acute hydramnios, which may have caused stasis. Therefore, in 6 out of 84 cases, or 7.1 per cent., where the urine was sterile at the beginning of pregnancy, pyelitis developed.

This corresponds with the finding in the other series of 96 cases, where pyelitis was diagnosed on clinical grounds in 7.3 per cent. of cases. It is realised that numbers are too small to generalise on the incidence of pyelitis of pregnancy but, while the figure 7.1 per cent. seems high, it must be remembered that few of those cases were seriously ill and the majority would have passed unnoticed but for careful examination.

When the cases are divided into primigravidae and multiparae it is found that the incidence of pyelitis is 8.1 per cent. in the former and 6.4 per cent. in the latter. Stasis occurred in 64 per cent. of the primigravidae and 40 per cent. of the multiparae, which probably accounts for the higher incidence of infection in the primigravidae.

This investigation indicates that 7 per cent. of normal, healthy pregnant women, in whom the urine is sterile at the beginning of pregnancy, develop infection of the upper urinary tract and that the development of such infection depends on the occurrence of stasis in the urinary tract. The striking feature of the literature on this subject is the great variation in the incidence of urinary infection during pregnancy, as estimated by different

workers. Engelhorn (1914), Danforth (1916), Zimmermann (1920) and Hewitt (1923) report organisms in the urine in "normal pregnancy" in from 50 to 80 per cent. of cases, while Albeck (1907) and Kincaid (1928) found the frequency to be 17 per cent. and 8 per cent. respectively. The variation in these figures is due to lack of uniformity in the criteria of what constitutes infection and "normal pregnancy". Where the incidence is found to be high, Staphylococcus albus is the most common finding on culture and this I consider is most often due to contamination. All these investigations are based on a single examination in each case during pregnancy, so that it is not known whether the infection developed during the pregnancy or was present beforehand, nor were urological methods used to determine the exact extent of the infection.

In the series examined cystoscopically there were no cases of intermittent bacilluria but in the first series there were 7 cases. In every instance the organisms were only present once during the pregnancy — 2 in the fifth month and 5 in the eighth. In 4 the organism was a staphylococcus and in 3 a coliform bacillus. In only 1 of those cases were any symptoms present, right-sided pain

being complained of coincident with the finding of organisms in the urine. There is little evidence of symptomless intermittent bacilluria being a common occurrence in pregnancy, although the possibility has not been excluded definitely as those patients were examined only once in four weeks throughout the pregnancy. Dodds concludes that there is no evidence of intermittent bacilluria during pregnancy. It is not definitely known whether organisms can be excreted by the healthy kidney without producing lesions. Helmholtz and Field (1925) consider that it does not occur, and Medlar (1926) found that in phthisical patients who were excreting tubercle bacilli in the urine, there were symptomless renal lesions. Earlier work by Brown and Cunningham (1915) had suggested that tubercle bacilli were excreted by the kidney without any lesion being produced.

In the 12 cases of the first series, pus cells were present alone in the urine and were not abundant in any.

(b) In a series of 1779 consecutive cases admitted to the antenatal wards of a maternity hospital.

The frequency of pyuria and bacteriuria in the antenatal wards of a maternity hospital can be more easily determined. For this purpose I have examined bacteriologically the urine of all patients admitted during the period of 4 years, from October 1928 to October 1932, to the antenatal wards of the hospital unit to which I am attached.

For the first two years note was taken of all degrees of infection, from even a few pus cells in the urine. The cases were divided into three categories — cases of pyelitis, cases of doubtful pyelitis, where the urinary infection was of doubtful significance in the production of the ill-health, and cases of mild infection which had probably no bearing on the condition for which the patient was admitted to hospital. It was found difficult to decide definitely about the significance of the infection in the cases of doubtful pyelitis, as is discussed on page 190, so that in the second two year period most of the mild infections were ignored and the doubtful pyelitis cases, with the exception of 5, were distributed throughout the other groups of antenatal complications, for

example, a case with a few pus cells and organisms in the urine and anaemia was classified as anaemia, although it is possible that the pyuria may have been responsible to some extent for the anaemia.

TABLE VII.

	My series of 1000 cases		Annual Hospital Reports					My series of 779 cases	
	Oct. 1928-29	Oct. 29-30	1926	1927	1928	1929	1930	Oct. 1930-31	Oct. 31-32
	%		%	%	%	%	%	%	
Pyelitis	156	15.6	-	-	7.5	7.4	8.4	109	14.0
? Pyelitis	101	10.1	-	-	-	-	-	5	
Abortion	152	15.2	17.6	19.1	14.7	20.5	16.7	95	12.2
Albuminuria	126	12.6	20.8	20.4	17.5	17.9	21.0	112	14.3
C.P.	96	9.6	13.4	11.1	10.0	9.8	12.7	112	14.3
Hypertension	75	7.5	6.5	5.7	7.7	8.1	9.2	54	6.9
Cardiac	51	5.1	6.0	5.9	6.1	5.5	8.4	32	4.1
A.P.H.	27	2.7	6.2	14.5	14.0	5.9	5.9	15	1.9

Table VII is an analysis of the total number of cases — 1779 — admitted to the antenatal wards during

the four year period. The first column represents the incidence of the various complications in the first two year period from an analysis of 1000 cases admitted. It is representative of the total admissions to the whole antenatal department of the hospital. Numerically it corresponds to the total admissions in a single year to the whole hospital. The other columns represent an analysis of the cases admitted each year from 1926 to 1930 taken from the official annual reports of the hospital. The various columns of figures are therefore comparable. The figures in my series indicate that pyelitis is one of the most frequent complications of pregnancy, reaching the high figure of 15.6 per cent., whereas the official report estimates the incidence at half this figure and indeed before 1928, it was diagnosed so infrequently as to be classified with the miscellaneous group of complications. The figures for the other complications, except albuminuria, agree fairly closely in the two series and the explanation of the disparity is probably wrong diagnosis. My figures are probably more accurate, as I examined the cases personally and carefully with this analysis in view. I have not relied upon hospital records but, for the sake of

uniformity, have kept my own case records. We may conclude that pyelitis is as common a complication in the antenatal wards as albuminuria, abortion and contracted pelvis. This is confirmed by the analysis of the cases admitted during the second two year period, shown in the last column of Table VII, where the incidence of pyelitis is given as 14 per cent., abortion as 12·2 per cent., albuminuria as 14·3 per cent. and contracted pelvis as 14·3 per cent.

This material was used to determine if there was any seasonal variation in the occurrence of urinary infection. A graph of the percentage incidence of all types of infection in each month of the year is shown in Fig. 96. There is no particular time of the year when infection is more liable to occur, although in one year the incidence was low in January and February. The second graph in Fig. 96 shows the incidence of infection in the various months of the year for the second two year period, when as mentioned above the very mild infections were omitted and only very definite infection considered. Here again no seasonal variation is seen.

In many cases it is quite impossible to tell,

however, in which month of the year the infection has originated, so that the graphs may not represent the true incidence in the various months. In many cases the infection is probably chronic and has been present for a long time. Where the condition is less chronic and even the cause of the pyrexia, it may simply be an exacerbation of a pre-existing infection, brought about by the occurrence of pregnancy. In primigravidae with primary acute attacks the time of onset can be fairly accurately dated. The third chart in Fig. 96 shows the percentage of acute primary attacks in each month in relation to the total number of admissions. The cases were put into the month in which the attack began, not into the month of admission to hospital. No seasonal variation could be established.

III. CLINICAL SIGNIFICANCE OF PYURIA AND BACTERIURIA IN PREGNANCY.

Even when the urine is heavily infected and urinary symptoms are present, it may be difficult to say definitely whether the inflammation of the urinary tract is responsible for such obstetrical complications as vaginal

bleeding, abortion, premature labour and intra-uterine death of the foetus. This difficulty becomes greater where the infection is slight or where the urinary symptoms are not prominent.

TABLE VIII.

Complication	Total	Number infected	%age infected
Pyelitis	156	156	100
? Pyelitis	101	101	100
Abortion	152	33	21.4
Albuminuria	126	33	26.2
Contracted pelvis	96	33	33.3
Hyperemesis	75	12	16
Miscellaneous	51	5	9.8
Cardiac	51	14	27.4
Normal	40	6	15
Antepartum haemorrhage	27	5	18.5
Malposition	23	3	13.4
Debility	25	5	20
Hydramnios	21	5	23.8
Oedema	16	4	25
Placenta praevia	15	2	13.3
Bronchitis	11	2	19
Varicose veins	9	2	22.2
Retroverted gravid uterus	2	2	100
Haematuria	3	1	33.3
	1000	424	42.4

Table VIII is an analysis of the 1000 cases admitted to the antenatal wards in the first two year period referred to above. It shows that 42.4 per cent. of the cases had some evidence of infection present in the urine —

pus and organisms in 314 cases

organisms only " 75 "

and pus cells only " 35 " .

The cases with evidence of infection in the urine have been differentiated into three groups:- (1) where the infection is of no importance as far as the obstetrical condition is concerned; (2) where the importance of the urinary infection is doubtful, and (3) cases of pyelitis where the infection is the important obstetrical condition.

Group 1. There were 167 cases in which the infection was regarded as of no significance. These included all the cases with pus cells only and organisms only, as well as 57 cases with pus cells and organisms. Table VIII shows that this mild type of urinary infection is just as common in cases of contracted pelvis as in cases of albuminuria toxaemia and there is no significant difference in the incidence in any of the antenatal complications. We are

thus justified in concluding that such urinary infection is of no clinical significance as regards the pregnancy. An analysis has been made in those cases to determine

(a) whether the infection occurred more frequently in primigravidae than in multiparae, (b) whether it could be traced to any previous infection or difficult labour, (c) if it was accompanied by urinary symptoms, (d) whether the incidence of constipation and septic teeth had any influence on the incidence of the infection, and (e) whether the organisms found differed from those found in pyelitis of pregnancy.

(a) It appears that infection is just as common in primigravidae as in multiparae, since there was infection of the urine in 32.7 per cent. of the primigravidae and in 36.5 per cent. of the multiparae.

(b) A history of previous urinary infection, either apart from pregnancy or at a previous confinement was obtained very seldom, which is not surprising as urinary infection in the puerperium is so often symptomless.

(c) Urinary symptoms are more common in those cases of mild infection than in cases free from infection, 21.1 per cent. as compared with 12.3 per cent.

(d) There was constipation in 22.7 per cent. of the infected cases and in 27 per cent. of uninfected, and septic teeth were present in 40.9 per cent. of infected cases and in 45.3 per cent. of uninfected. In these cases of slight infection then, constipation and septic foci do not appear to be of any importance in the production of the infection. Dodds also finds that septic teeth and constipation do not predispose to urinary infection. Bumpus (1921), however, points out that the appearance of teeth is no guide to the presence or absence of sepsis in them, as he has found streptococci at the root of apparently normal teeth, following removal of which urinary infection occurred in some cases.

(e) The type of organism found in these cases of mild infection varied a great deal —

coliform organisms in	27%
" " and cocci in	7.2%
staphylococci and streptococci in	22.7%
unclassified organisms in . . .	27%.

There were pus cells only in 16%.

The unclassified group includes organisms which did not grow on culture and many of them were slender Gram-negative

bacilli situated often in large numbers inside epithelial cells. It seems unlikely that these were contaminations as they were found repeatedly in the same cases examined at intervals. Coliform organisms do not predominate to the same extent as in cases of pyelitis and frequently there were several types of coliform organism present, whereas in pyelitis there is as a rule only a single type present. This has already been considered in detail in the section on bacteriology.

To determine the effect of this mild type of urinary infection on the health, the incidence of such symptoms as anaemia, sickness, jaundice, lack of appetite and loss of weight in this group has been compared with the incidence in the group where the urine is sterile. Table IX shows the results.

TABLE IX.

	Anaemia	Sickness	Jaundice	Appetite	Loss of weight
Infected cases	37.5	32.3	8.8	23.5	11.7
Non-infected cases	45.9	37.7	12.3	28.3	19.9

In the infected group the incidence of these symptoms is lower than in the uninfected cases. As we shall see in the pyelitis cases, all these symptoms are much more frequent than in the cases where the urine is sterile, despite the fact that the latter include patients with hyperemesis, debility and anaemia.

When each group of antenatal complications is examined in detail the same general conclusion is arrived at, that the infection has little bearing on the obstetrical condition.

Group 2. There were 101 cases in which the urinary infection was regarded as of doubtful significance. The diagnosis on admission was —

abortion	23
albuminuria	18
contracted pelvis . .	12
hyperemesis	8
cardiac	7
premature labour . .	5
antepartum haemorrhage	4
debility	4
hydramnios	4
undiagnosed	4
varicose veins . . .	2
pruritis	2
cystitis	2
mental condition . .	1
appendicitis	1
pyelitis	1
placenta praevia . .	1
malposition	1
vaginal cyst	1

Total 101

There were 23 primigravidae and 78 multiparae in this group. History of previous urinary infection was more frequently found than in Group 1, in 30·7 per cent. Urinary symptoms were also more frequent, occurring in 45·5 per cent. of cases. There is greater incidence of septic teeth but little difference in the incidence of constipation. The organisms found in this group were —

coliform organisms alone in . .	62·3%
" " and cocci in	18·9%
staphylococci and streptococci in	9·9%
unclassified organisms in . . .	5%

There were pus cells only in 3·9%.

There is a notable increase in the incidence of coliform organisms as the cause of infection — 62·3 per cent. as compared with 27 per cent. — and a decrease in the unclassified group of organisms — 5 per cent. as compared with 27 per cent. The findings approach to some extent those in Group 3, the pyelitis cases, where the incidence of infection due to coliform organisms alone was 87·8 per cent. The evidence all points to a more definite infection of the urinary tract by a specific organism, most frequently coliform.

The following is a short analysis of each group of antenatal complication, to consider the importance of the urinary infection in each.

Abortion. There were 23 cases — 9 threatened and 14 inevitable. Urinary symptoms were present in 13, suggesting infection of the upper urinary tract in 10 and cystitis in 5. It is quite impossible to assess accurately what part the urinary infection played in the production of the abortion, but in 11 cases it was probably a predisposing factor at least, and in 4 of those it was probably the cause. In 5 of these 11 cases the conclusions were arrived at with the aid of cystoscopy and pyelography.

Out of 175 cases of abortion in the whole series of 1000 antenatal cases, the urinary infection was partly responsible for the abortion in 11 cases or 6.3 per cent.

Albuminuria. There were 18 cases — 7 primigravidae and 11 multiparae. Oedema was present in 7, albumen in 12, raised blood pressure in 8 and urinary symptoms in 6. Most of the patients had symptoms of mild toxæmia and in 9 the urinary infection was probably the cause of the toxæmia. In 5 of those 9 cases there was no albumen in the supernatant urine after centrifugalisation, and the symptoms corresponded to those of chronic pyuria, lack of appetite and loss of weight. The remaining 4 of those 9 had albumen in the urine and 2 had slightly raised blood pressure but no oedema. They also had symptoms corresponding to those of chronic pyuria. Those 9 cases were wrongly diagnosed in my opinion and should have been in the pyelitis group.

The remaining 9 patients in this group, all multiparae, had albuminuria, oedema and raised blood pressure. 2 had pain along the course of the ureters, suggesting infection of the upper urinary tract. They did not, however, have symptoms suggestive of septic absorption.

Therefore, out of 135 cases definitely shown to be albuminuric toxæmia in the series of 1000 admissions, there were 9 multiparae who also had inflammation of the urinary tract. It is possible that the urinary infection dated from a pyelitis of a previous pregnancy and that the albuminuric toxæmia was superimposed in the present one. It is difficult to say whether the previous urinary infection had so damaged the kidneys as to make them more susceptible to the toxic effect of a subsequent pregnancy, but acute pyelo-nephritis of pregnancy almost never causes a rise of blood pressure or oedema and seldom more than a faint haze of albumen in the urine. In multiparae the two conditions are found together but it is certain that the oedema and rise of blood pressure are not due to the infection by the coliform bacilli. In previously healthy primigravidae who develop albuminuric toxæmia, no accompanying urinary infection is found. As has been shown, a few organisms are occasionally present but these are of no significance. I have never seen a primigravida previously healthy, who had a pyelitis during the pregnancy, develop albuminuric toxæmia later in the same pregnancy, and it appears as though the predisposing factors in the two conditions were opposed.

Dodds, from a small series of 37 cases of albuminuric toxaemia finds the urine sterile in 35 and states that bacteriuria is not more frequent in pregnancy toxaemia than in normal pregnancy. This is confirmed by Garofalo (1933) who postulates the theory that the infrequency of urinary infection in albuminuria of pregnancy is due to increase of oxybutyric acid, so that there is a hyperketosis, which is bactericidal. On the other hand, De Lee (1928) and Ivens (1928), on rather insufficient evidence, state that some of the toxaemias of pregnancy are due to urinary infection, and Talbot (1923) states that in some cases of albuminuric toxaemia the placental infarctions found are due to haematogenous infection from the urinary tract. O'Sullivan (1933) divides pyelitis of pregnancy cases into 2 groups; those with normal blood pressure and those with raised blood pressure. In a series of 46 cases 21 per cent. had raised blood pressure. He gives no evidence of when the urinary infection developed or of its extent, so that these were probably cases of superimposed albuminuric toxaemia on chronic urinary infection dating from a previous pregnancy. Ryle (1932) holds that the two conditions are not uncommonly found together and states that if the Esbach reading in the

filtered specimen of urine is more than one $\frac{1}{2}$ part, albuminuric toxæmia is present as well as urinary infection. Band (1933) states that hæmaturia and albuminuria frequently precede the onset of an acute attack of pyelitis of pregnancy. I have never encountered such a case during the past five years.

Contracted pelvis. There were 12 cases of contracted pelvis with urinary infection. Only 3 felt well during the pregnancy. 6 had definite urinary symptoms and 3 symptoms of septic absorption. Thus, although all the patients in this group were admitted to hospital because of contracted pelvis, 9 of them had urinary infection which was affecting their health. In assessing the incidence of pyelitis in the series therefore, these cases would have to be taken into account.

Hyperemesis. There were 8 cases of hyperemesis with urinary infection. 4 had symptoms referable to the upper urinary tract and in these cases the sickness was probably due to the urinary infection, as 3 occurred from the fourth month onwards, unlike true hyperemesis. My experience has been that hyperemesis is not associated with urinary infection nor particularly liable to be followed by it.

I have been impressed, on performing chromocystoscopy in cases of hyperemesis, by the efficient emptying of the ureters in spite of the very much reduced fluid intake. In certain severe cases examined, no fluid had been taken for 24 hours before the examination.

Cardiac disease. There were 7 cases in this group. In 5 there were urinary symptoms and the infection seemed to be of some importance. 4 of the 5 were multiparae and none had had cardiac embarrassment with any previous pregnancy. The toxic effect of the urinary infection may have contributed to the break down in the present pregnancy.

Premature labour. There were 5 cases admitted because of threatened premature labour. 3 were in the eighth month of pregnancy and the pain was renal in origin and disappeared on treatment of the urinary infection so that these were probably cases of pyelitis. 2 were near term and had bladder symptoms which probably accounted for the bearing down feeling complained of.

Antepartum haemorrhage. There were 4 of these, in 1 of which the bleeding was very slight in the seventh month and had been preceded in the fifth month by what from the history appeared to be a bilateral pyelitis. The bleeding was probably the result of the infection in this case.

Pyelitis does not as a rule cause bleeding in the later months of pregnancy. In a series of 156 consecutive cases of pyelitis, vaginal bleeding in the later months of pregnancy occurred only in 3, in one of which it was due to a placenta praevia. In the other 2 cases there were signs of nephritis probably caused by the pyelitis which was of some years' duration, and the haemorrhage was probably of the apparent accidental type.

Debility. There were 4 multiparae in this group, and all had symptoms of mild cystitis; it is probable that there was no infection of the upper urinary tract with

toxic absorption.

Hydramnios. There were 4 cases, in 2 of which the symptoms were adequately accounted for by the distension. In the other 2 the hydramnios was slight and the clinical picture was rather that of chronic pyelitis than pressure from hydramnios.

Undiagnosed cases. There were 4 cases admitted without a diagnosis. One complained of pain in the back, which was probably postural. Another had pain in the right iliac fossa probably due to adhesions from a previous appendicectomy, and one had pain probably due to muscular rheumatism. The fourth complained of sleeplessness and was undoubtedly a case of chronic bilateral pyelitis.

Varicose veins. There were 2 cases, one of which was admitted because of varicose veins of the legs but had debility as the result of the urinary infection. The other case had varicose veins of the vulva for which she was admitted but had also severe right-sided pain relieved by the passage of a ureteral catheter and therefore of urinary origin.

Pruritis. There were 2 cases, in which the urinary infection was probably the important cause of the irritation as they had pain and frequency of micturition and no evidence of local redness.

Cystitis. There were 2 cases, correctly diagnosed.

The other single cases were — one admitted as vaginal cyst, which was really a diverticulum of the urethra with infection; a case of retroversion of the gravid uterus with a urinary infection; a mental condition in which the urinary infection played no part; chronic appendicitis probably correctly diagnosed; pyelitis which was probably a case of chronic nephritis with cystitis; a case of placenta praevia where the urinary infection contributed to the debility but not to the bleeding, and a case of breech position with cystitis.

To summarise, in this group of 101 antenatal cases with urinary infection of doubtful significance, in 48 or 47.6 per cent. the urinary infection was probably the most important cause of the patient's ill-health and required treatment before the health would be satisfactory.

Group 3. Cases of pyelitis where the infection is the important obstetrical condition. This will be dealt with under a special heading, Pyelitis of Pregnancy.

IV. PYELITIS OF PREGNANCY.

Definition. Pyelitis is inflammation of the renal pelvis. When the renal parenchyma is affected, the condition is termed pyelo-nephritis. I have used the term pyelitis in this study to include both types, as it is often very difficult to decide whether the inflammation is limited to the kidney pelvis or not. Many urologists consider simple pyelitis to be rare, and that most often the renal parenchyma is primarily infected, with secondary involvement of the renal pelvis. Wilson and Schloss (1929) found at autopsy in a series of cases of pyelo-nephritis in children,

that the renal pelvis was seldom involved. In pregnancy, however, there is obstruction to outflow and consequent stasis in the upper urinary tract which makes the kidney pelvis and ureter more liable to infection, without the parenchyma being necessarily involved.

Etiology.

(a) Incidence. Table VII on page 179, from an analysis of the cases admitted to the antenatal wards of one hospital unit during a period of 4 years, shows that pyelitis is one of the most common complications of pregnancy. For the first 2 year period the incidence was 15.6 per cent. of all the admissions to the antenatal wards of the unit and for the second 2 year period 14 per cent. It is as common as albuminuric toxæmia, contracted pelvis and abortion. As a result of this investigation it is now realised that infection of the urinary tract during pregnancy is much more common than was formerly supposed and it is now a routine procedure throughout the hospital to have a catheter specimen of urine examined bacteriologically in every case admitted to the antenatal department. Many cases, formerly classified as mild albuminuric toxæmia, have

proved to be cases of chronic pyelitis. My figure for the incidence of albuminuric toxæmia for the first 2 year period is 12·6 per cent. as compared with 18·8 per cent., the average incidence for the years 1928 to 1930 in the hospital report, and my figure for the incidence of pyelitis for the same period is 15·6 per cent. as compared with 7·9 per cent. in the hospital report. The figures for contracted pelvis and cardiac disease, easily recognised complications of pregnancy, are fairly constant throughout the different years and agree with the figures in my series, so that the disparity in the pyelitis and albuminuric toxæmia groups is probably explained by the fact that cases classified in the hospital report as albuminuric toxæmia, have been diagnosed in my series as pyelitis.

I have been unable to demonstrate any seasonal incidence in pyelitis of pregnancy. This is what one would expect if the onset of pyelitis is dependent on the occurrence of stasis in the urinary tract during pregnancy, except that the occurrence of enteritis during the summer and autumn months might play some part in facilitating the transference of the coliform organisms to the urinary tract.

Out of the total of 156 cases of pyelitis of pregnancy in the first 1000 cases admitted to the antenatal

wards, 57 were primigravidae, or 36.5 per cent. which is a higher proportion of primigravidae than in any other complication of pregnancy except albuminuric toxæmia. Out of 284 primigravidae admitted to the antenatal wards for all causes, 57 suffered from pyelitis, or 20 per cent. There were 99 cases of pyelitis in 716 multiparae admitted, or 13.8 per cent. We conclude, therefore, that pyelitis occurs more frequently in primigravidae than in multiparae or that it more frequently needs hospital treatment in the former. This is borne out by an analysis of the cases, which shows that the disease is more serious in primigravidae than in multiparae. In some multiparae the condition is an exacerbation of a pre-existing infection which may or may not have been acquired during a previous pregnancy. The following is an analysis of the history of previous urinary infection in 231 multiparae, suffering from pyelitis.

Urinary infection in previous pregnancy	39	(In 16 the primary attack was in the first pregnancy.)
Urinary infection in the puerperium	13	
Urinary infection apart from pregnancy	<u>10</u>	
Total number of multiparae with history of previous urinary infection	<u>62</u>	out of 231, or 26.8%.

Where no history of previous urinary infection could be obtained, it may safely be concluded that in some cases urinary infection existed before the onset of the pyelitis of pregnancy. Nevertheless, in more than half of the cases of pyelitis of pregnancy in multiparae, it is certain that no pre-existing infection of the urinary tract was present. Whether the urine is infected previously or not, pyelitis of pregnancy is milder in multiparae than in primigravidae.

(b) Predisposing factors. The most important predisposing factor in the production of pyelitis of pregnancy is stasis of urine in the upper urinary tract. This is a well recognised fact in the non-pregnant but is even more striking in pregnancy. A clinical study shows the clear relationship between the time of onset of stasis in the urinary tract in pregnancy and the time of onset of pyelitis.

TABLE X.

Time of onset in months pregnant.								Totals.
Parity	3m	3-4	4-5	5-6	6-7	7+	No definite time	
Prim.	10	3	59	40	13	20	10	155
Multip.	35	18	32	44	43	37	26	235
<div style="text-align: center;"> 64% 32% </div>								<u>390</u>

Table X is an analysis of the time of onset of infection in a series of 390 cases of pyelitis. In primigravidae the time of onset of infection is much more constant than in multiparae. In 64 per cent. of the primigravidae the attack began between the fourth and sixth months, compared with 32 per cent. of multiparae at the same stage of pregnancy. As has already been shown on page 93, this is also the case as regards the time of onset of stasis. In primigravidae stasis occurs very frequently in the fifth month, whereas in multiparae the time of onset of stasis is much more variable. It will be recalled also that in some primigravidae, stasis did not appear until later in the pregnancy, as late as the seventh month. This may explain

the late onset of pyelitis in some cases, but in others it may be due to absence of infecting organisms, although stasis has been present for some time. The fact that stasis may be present for some time before infection develops is illustrated by the case of Mrs. R., whose pyelogram is seen in Fig. 75, in whom at the fourth month there was marked dilatation of both renal tracts with stasis, but in whom infection did not occur until 2 months later, when bilateral pyelitis developed.

Stasis always precedes the onset of infection. In a series of 84 healthy pregnant women, 43 developed stasis during the course of pregnancy; 5 developed pyelitis and in each case marked stasis of the urinary tract preceded the onset of infection. 41 did not develop stasis and only 1 of these developed pyelitis, in whom infection followed the occurrence of acute hydramnios, which would probably cause stasis. Where the stasis is bilateral, the subsequent infection is bilateral. This is illustrated in the case of Mrs. R. quoted above. Where the stasis is unilateral, the infection is unilateral, at least in the early stages. This is illustrated by the case of Mrs. B., in whom marked stasis of the right ureter developed at the fourth month, when there

were no urinary symptoms. At the end of the sixth month she was re-examined because of right-sided pain, which disappeared immediately on passing a ureteral catheter. The urine contained a few pus cells but no organisms. In the eighth month acute right-sided pyelitis developed. The pyelogram taken at this stage, Fig.97, shows the gross dilatation and kinking of the right urinary tract with no abnormality on the left side. Stasis in the eighth month, after infection had developed, was less than in the sixth month, before the onset of infection.

In 8 of the 10 primigravidae and in 17 of the 35 multiparae, in whom the symptoms of infection appeared at or before the third month, a history of previous urinary infection was obtained. In these cases the primary atony of the ureters caused stasis and was probably responsible for the lighting up of the pre-existing infection at this early stage of pregnancy. With the exception of those cases and one other, there was no reason to suppose in the primigravidae that there had been a pre-existing infection. Similarly, in the cases of multiparae who developed pyelitis before the end of the third month, the incidence of previous urinary infection was much higher, 48 per cent., than in

those who did not develop pyelitis until later in the pregnancy, where it was 23 per cent. The incidence of previous urinary infection is much greater in multiparae than in primigravidae, indicating the importance of previous pregnancy in the production of infection in the urinary tract. Numerous authors believe that pyelitis of pregnancy is a lighting up of pyelitis of infancy. Koll (1917) states that a history of pyelitis of infancy could be obtained in 90 per cent. of cases of pyelitis of pregnancy where the mother was intelligent. Kretschmer and Falls (1923), Williams (1925), Pugh (1927) and Rose and Rollins (1931) all believe that the infection is present from childhood in an attenuated form. Beeler and Helmholtz (1916), however, find that in young girls where there are no symptoms the urine is free of infection.

In primigravidae it was difficult to obtain reliable figures of pyelitis in childhood, but in a few cases this was definitely known to have occurred. In some the urine had become sterile in the interval and pyelitis of pregnancy did not occur. In those cases where the urine had remained infected either no exacerbation occurred during pregnancy or, as has been shown already, the onset of

symptoms occurred much earlier in the pregnancy than is usual in acute primary pyelitis. Crabtree and Prather (1933) report 34 cases which had a history of previous urinary infection before the first pregnancy and 27 of those had sterile urine during the pregnancy. Six had a febrile disturbance with infection of the urine and in those it was presumed that the urine had not become sterile before the onset of pregnancy.

I have shown in Chapter III that pregnancy produces marked dilatation and kinking of urinary tracts previously normal. Five women have developed pyelitis of pregnancy while under observation and in all of them intravenous pyelography showed that the urinary tracts were normal before the onset of the stasis which preceded the attack of pyelitis. In many cases the urinary tract has been observed to return to normal after the delivery and in a subsequent pregnancy pyelitis did not develop. Therefore we conclude that inherent abnormality in the urinary tract, such as stricture and congenital narrowing or kinking of the ureter at certain points, is not a necessary factor for the development of pyelitis of pregnancy and, in fact, is seldom found. These findings have been confirmed by Crabtree (1927).

The state of health of the patient is not a factor in the production of pyelitis, as it is striking that pyelitis of pregnancy occurs most typically and in its most severe form in healthy young primigravidae, nor does it appear to be associated with any particular physical type. Ryle (1932) finds in the non-gravid that 'dark and sallow women of hyposthenic habit' are more liable to pyelitis, probably because of intestinal sluggishness. Hofbauer (1928) finds a lowered opsonic index in 6 out of 53 pregnant women and points out that this incidence of 1 in 9 corresponds to the incidence of urinary infection as estimated by Pugh (1927) of 1 in 10. He considers that the lowered opsonic index indicates lowered resistance to infection and would thus constitute a predisposing factor in the production of pyelitis. While lack of resistance to infection by coliform organisms may play a part, the opsonic index is of doubtful value in estimating it and there is no proof given that those, in whom the opsonic index was low, developed urinary infection.

A history of fatigue or chill is often obtained in cases of pyelitis of pregnancy. They may act as predisposing factors by lowering the patient's resistance to infect-

ion. Kidd (1920) believes that these are most important predisposing factors to all infections of the urinary tract.

In the French literature (Le Lorier and Fisch, 1927), much has been made of the injurious effect of chemical constituents of the urine, such as oxalate crystals, on the mucosa of the urinary tract.

Penkert (1933) considers that the tissues of the ureter are more susceptible to infection because of thickening and proliferation of the epithelium of the ureter by oedema and hyperaemia.

In my series, no relationship was found between the incidence of septic foci and urinary infection. Dental caries, septic tonsils and constipation were just as common in patients with sterile urine as in those with pyelitis.

(c) Infecting organism. The infecting organism in pyelitis of pregnancy belongs to the coliform group in over 90 per cent. of cases. It seems likely that it is derived from the bowel and the types of coliform organism found in the urine in pyelitis are those which are normally abundant in the bowel. In a number of cases I have been able to isolate from the faeces the identical organism present in

the urine. Bitter and Gundel (1924) and Herrold (1922) in cases of pyelonephritis have isolated similar strains from the faeces; these were identical by agglutination experiments. It is well recognised in pyelitis of childhood that the onset frequently follows intestinal disturbance such as diarrhoea, and a number of cases of pyelitis of pregnancy in my series gave a clear history of the onset following either an enteritis or, as was much more common, drastic purgation after a period of constipation.

In the non-pregnant, urinary infection is most often due to coliform organisms also. Band (1933), in a series of 3,000 cases of urinary infection in the non-pregnant, found coliform organisms in 76.3 per cent., coliform mixed with other organisms in 15.4 per cent. and streptococci in 8.5 per cent.

Some workers, mainly from the results of animal experiment, are of the opinion that coliform organisms are secondary invaders and that the infection is due primarily to a streptococcus which reaches the kidney by the blood stream from septic foci elsewhere in the body. Bumpus and Meisser (1921) found that streptococci obtained from the teeth and tonsils of patients suffering from pyelitis

produced kidney lesions in rabbits when injected intravenously much more readily than coliform organisms from the urine of patients with pyelitis. Lepper (1921) found however that, after partial ligation of the ureter, infection of the kidney with coliform organisms was much more readily produced. In pregnancy this predisposing factor of obstruction to outflow is present, so that it is unnecessary to postulate primary infection by another organism.

(d) Mode of origin. There are three principal routes by which infection may reach the kidney — by the blood stream, by the lumen of the ureter and by the lymphatics. The majority of clinical workers in this country believe that the organism is absorbed from the bowel and carried to the kidney by the blood stream.

Experimental work indicates that absorption of organisms from the bowel can occur. David and McGill (1923) state that more than 50 per cent. of the mesenteric glands of dogs contain organisms, 33 per cent. of which are coliform. They believe that organisms normally get into the blood stream in small numbers but lowered resistance of the host or lesions of the bowel allow greater numbers to

gain entry. Price-Jones (1926) came to the same conclusion by feeding Gaertner's bacillus to white rats, which caused no harm when the rats were in normal health but easily passed into the system and caused illness, if the rats had been fatigued.

In human beings, Redewill, Potter and Garison (1930) claim very good results in the treatment of chronic pyuria by altering the intestinal flora. They believe that intestinal absorption is a real danger and attribute their good results to cutting off the infecting organism at the source. Kennon (1932) states, although he gives no proof in the paper, that intestinal colic, as a result of purgation, may produce bacilluria so intense as to cause haematuria and transient albuminuria. Kidd (1920) says that the infection in pyelitis is practically always by the blood stream from the bowel. In his opinion organisms are constantly being absorbed from the bowel into the circulation in small numbers and only if in unusually large numbers when the patient's resistance is lowered, do they cause damage and give rise to symptoms. Ryle (1932) states that "clinical observation closely favours blood-borne infections and the biliary and urinary tracts become infected during the

excretion of the organisms. The duration of the bacillaemia is short and ends when the bacilluria begins. If the urinary outflow is impeded the bacilluria may undoubtedly persist."

Middleton (1929), Schockaert (1926) and Penkert (1933) state that in pregnancy the infection is blood-borne but give no proof. Achard (1929) states that in 90 per cent. of cases the infection in pyelitis is blood-borne. The majority of workers obtain negative blood cultures in cases of pyelo-nephritis, a fact which has been used as an argument against the infection being blood-borne. In my experience also, the blood culture in established cases of pyelitis of pregnancy is usually negative. In a series of 80 cases of pyelitis of pregnancy, specially selected because of the severity of the condition, I obtained a growth on blood culture in only one case which I describe shortly.

Mrs. McG., a primigravida, admitted in the sixth month of pregnancy with an acute attack of left-sided pain of 24 hours' duration, temperature 104° , pulse rate 120 - 140. The following day she developed severe right-sided pain and a coliform organism was grown from the blood, taken on the same day. The temperature settled in 12 days and the pregnancy continued to full time.

In this case there were several features favourable to

obtaining a positive blood culture; the short duration of the illness before blood culture was done, the very acute onset and the fact that, on the day the blood was taken for culture, the infection probably spread from the left kidney to the right.

The negative blood cultures in established cases of pyelo-nephritis of pregnancy suggest that dissemination of the infection from the kidney back into the blood stream is not usual. It is possible that blood culture taken at the beginning of the illness would be positive and a few days later negative, when the disease is well established. In other words, a temporary bacillaemia probably occurs at the onset of the disease. I have observed during the last three years 4 patients, being treated in the antenatal department for other conditions, develop an acute pyelitis and in all of them the infecting organism was isolated from the blood stream at the beginning of the attack. The urine was sterile before pyelitis developed in all 4 cases. These cases were —

(1) Mrs. C., case sheet no. 12, aged 13 years, admitted at 35 weeks because of her age. Two unsuccessful attempts at induction of labour by Watson's medical method

were made, after which (see chart) she developed a temperature of 102° with acute right-sided pain. Streptococcus faecalis was grown in culture from the blood. Four days later cystoscopic examination showed that on the left side there was no stasis with sterile urine and on the right side, marked stasis with urine heavily infected with pus and Streptococcus faecalis. The urea concentration on the right side was less than half that on the left. The predominating organism in a culture of the faeces was also the Streptococcus faecalis. The following day she went into labour. On the second day post-partum she had a rigor and the temperature rose to 102° and on this occasion the blood culture was negative.

In this case it is certain that the disturbance of the bowel, due to the drastic purgation of the medical induction, allowed the Streptococcus faecalis to gain access to the blood stream and infect the right kidney. It is interesting to note that the left kidney urine was not infected and that on this side there was no stasis. It might be argued that the organisms were excreted by the kidneys but that on the left side the absence of stasis prevented the organisms settling and giving rise to inflammation. We cannot tell, however, whether any of the organisms were excreted by the kidney or not. Helmholtz (1925) is of the opinion that bacteria are not excreted by a healthy kidney but only as the result of some pathological condition. He believes that bacteria injected intravenously in animals undergo

phagocytosis and their toxins produce local tissue necrosis in the kidneys by which they are excreted, because he found that, even where virulent staphylococci were injected, they did not appear in the urine until after 7 hours, and less virulent coliform organisms did not appear until after 24 to 48 hours after injection. The organisms were not excreted until their toxins had produced sufficient damage in the kidney to allow them to pass. According to this theory, the organisms would not be excreted by the healthy left kidney so readily as by the right, which would be more easily damaged by toxins owing to the stasis which is present in the right renal tract in the majority of pregnant women. Apart from infection, the right kidney substance is probably damaged in many pregnant women by the existing stasis, as is evident from the low concentration of urea found in the urine from the right kidney.

(2) Mrs. G., a III-para, case sheet no.13, admitted in the eighth month of pregnancy because of mild albuminuria of pregnancy. The urine was sterile. She was given Epsom salts every morning and this produced diarrhoea. On the fifth day after admission she developed sudden severe pain in both kidney regions and a temperature of 102°. Coliform organisms were grown on culture from the blood. Pyrexia lasted for 2 weeks, at the end of which she went into labour prematurely. Five days post-partum cystoscopic examination showed that both kidney urines

were infected. The same organism was obtained from the urine, vagina, blood and faeces, and it was agglutinated by the patient's serum up to a titre of 1/800.

(3) Mrs. F., a primigravida, case sheet no.14, admitted during the eighth month, with mild albuminuria. She had Epsom salts daily and on the third day after admission developed a pain in the right side with pulse rate of 96. On the following day temperature rose to 99° and pulse rate to 110. On the fifth day after admission she had a rigor and organisms were found in the blood. Labour began the following day but the temperature remained elevated in the puerperium. On the fifth day post-partum a cystoscopic examination showed marked atony of both ureters and that both renal tracts were heavily infected. The same coliform organism was isolated from urine, vagina, blood and faeces, and was agglutinated by the patient's serum up to a titre of 1/1600.

In cases 2 and 3, the organism in the urine undoubtedly came from the bowel by the blood stream, the absorption from the bowel into the blood stream being facilitated by the disturbance caused by the Epsom salts.

(4) Mrs. McG., a IX-para, case sheet no.15, admitted in the seventh month of pregnancy because of severe albuminuria. Intestinal disturbance was again in this case caused by salts and on the eighth day after admission the patient had a rigor and pain in the epigastrium. Blood culture was positive. The following day the membranes were ruptured to induce labour and delivery occurred 2 days later. The same day she developed marked tenderness over the left kidney and slight tenderness over the right. The same organism was isolated from all four sources.

In those 4 cases, therefore, the sudden rise of temperature,

usually with rigor, was preceded by frequent bowel movements as a result of purgatives, either salts or castor oil. In all 4 the organism causing the urinary infection was isolated from the bowel and blood. It seems reasonable to conclude that the organism came from the bowel. It may be objected that the patients were at a later stage of pregnancy than is usually associated with the onset of pyelitis, but I think this is due to the overwhelming proportion of patients in the later months of pregnancy in the antenatal wards. In the case of pyelo-nephritis where the patient has been infected for variable periods of time, from several weeks to several years, the organism in the urine is much less frequently obtained from the faeces than in the 4 cases described. This is because the flora in the bowel probably varies from time to time. In the puerperium where I could observe pyelitis in its initial stages, the organism in the urine was isolated from the bowel much more frequently.

Organisms were found in the blood in 2 other cases of pyelitis of pregnancy, but they have been described on page 223 .

The conclusion one arrives at is that if blood was taken for culture early enough in the disease, a positive

result would be obtained and that following intestinal disturbance organisms are absorbed into the blood stream, by which they are carried to the kidney.

Some workers still believe that spread upwards by the lumen of the ureter from the bladder is the most common mode of infection in pyelitis. Helmholtz (1932) finds that spontaneous pyelitis in rabbits is always ascending as judged by the distribution of the inflammation in the kidney. Eisendrath and Rolnick (1930) and Cabot and Crabtree (1916) hold that there is no pathological difference in the kidneys between pyelitis of ascending and that of descending origin. Luchs (1925) says that ascending infection must sometimes occur during pregnancy, as he has demonstrated reflux in the later weeks of pregnancy. Pyelitis does not as a rule occur at this late stage of pregnancy, however, and cystitis is relatively uncommon during pregnancy. Schumacher (1931) finds that ureteral reflux does not occur during pregnancy.

Experimentally it has been shown that where the ureterovesical ostium does not function satisfactorily the contents of the bladder may ascend along the ureter to the kidney pelvis. This has been done by Gruber (1928), who performed unilateral meatotomy in dogs and then injected

cultures of organisms into the bladder. He produced inflammation of the kidney twice as often on the meatotomy side as on the other. The bladder contents are probably forced into the ureter by the activity of the bladder where the ureteral orifice is patulous. In another investigation Gruber (1930) excised the ureterovesical valve in dogs and 2 to 5 months later found dilated ureters and in some cases dilated kidney pelves. In those cases he saw anti-peristalsis. Where there is induration or fixation of the valve so that it does not function normally, hydronephrosis may develop. It has been stated that the hypertrophy at the lower end of the ureters in pregnancy may prevent adequate functioning of the ureterovesical valve, and thus explain the dilatation of pregnancy and also the occurrence of pyelitis of pregnancy. While during pregnancy the ureteral orifices often appear unduly prominent, they are seldom patulous. In the puerperium, however, especially if there is bruising of the pelvic cellular tissue or cystitis, the orifice may become fixed and inactive. Ascending infection may thus readily occur in the puerperium under these circumstances. The following case illustrates a probable ascending infection of the urinary tract. A II-pa-

in the ninth month of pregnancy was found, on cystoscopic examination, to have a gaping left ureteral orifice. The urine from the left kidney and bladder contained pus cells, coliform organisms and Doederlein bacilli. The urine from the right kidney contained pus cells and coliform organisms only. On the tenth day post-partum the urine from the left kidney was sterile although the condition of the urine from the bladder and the right kidney was unchanged. It seems likely that the Doederlein bacilli in this case had spread upwards from the bladder along the lumen of the ureter.

Kamniker (1929) has shown that with a catheter in the lower half of the ureter during the second half of pregnancy, it is not possible to obtain a retrograde pyelogram of the upper part of the ureter and kidney pelvis because of obstruction at the level of the pelvic brim. In the non-pregnant satisfactory pyelograms are easily obtained by this method. This is strong evidence against the possibility of ascending infection in pregnancy, although exceptionally it may occur.

Gruber and Rabinovitch (1930) are of the opinion that ascending infection along the wall of the ureter from the bladder by the lymphatics is unlikely as the bladder and

lower third of the ureter drain into the hypogastric glands, the middle third into the lumbar glands and the upper third into the glands along the vena cava, so that the possibility of direct communication between them seems remote. Although such an origin of renal infection may be difficult to demonstrate experimentally and histologically, yet it seems a likely explanation of some of the clinical phenomena. Hess has been able to show round-celled infiltration in the lymphatics of the periureteral sheath in ordinary pyogenic infections. It has been stated by numerous authors, most recently by Gibberd (1932), that pyelo-nephritis of pregnancy is due to lymphatic spread and the right side is affected more than the left, since the contents of the ascending colon are more fluid and more easily absorbed than those of the descending, and the right kidney pelvis in closer contact with the ascending than the left kidney pelvis is with the descending colon. Winsbury White (1933) shows how dye substances injected into the cervix uteri find their way along the lymphatics to the ureter, and he is of the opinion that many cases of chronic urinary infection are kept up by reinfection from the cervix, and that permanent cure will only result when the cervix is suitably treated.

As will be shown later, the infection in pyelitis of pregnancy is much more often bilateral than unilateral and depends largely on whether the stasis is unilateral or bilateral, so that Gibberd's explanation of the mode of spread, in the absence of definite proof to support it, seems unlikely. In pyelitis of pregnancy the bladder is very rarely infected to any great extent and is not primarily infected, so that spread of infection from the bladder along the lymphatics does not enter into the question.

Pathology.

Acute pyelo-nephritis is usually bilateral, except in very fulminating cases where it may be unilateral. In the early stages the entire surface of the kidney reveals innumerable minute haemorrhagic areas. If the bacteria are less virulent there are innumerable abscesses, varying in size from miliary to large soft yellow areas, scattered over the surface or in groups. On section of the kidney one sees either minute abscesses or streak-like yellow areas, radiating from the medulla to the cortex. Microscopically the punctate haemorrhages are bacterial emboli, filling the loops of capillaries of many glomeruli or packing the inter-

lobular vessels. Surrounding these are necrotic areas and round these, marked reaction of the tissue of the kidney. The appearances do not differ in the haematogenous from the other modes of invasion. There is little walling off of the suppurative areas. The mucosa of the kidney pelvis is swollen and red.

There are 3 types of lesion found in subacute and chronic pyelo-nephritis.

(a) The parenchyma is more involved than the kidney pelvis. If the organism is avirulent and the local resistance good, fibrosis not unlike a non-bacterial nephritis results, which if diffuse will lead to an atrophic kidney, if patchy to irregularities of the cortex due to scars and retracted areas. Secondary calculus formation is common. There is only moderate dilatation of the calyces, as usually obstruction to outflow is not present.

(b) The kidney pelvis is more involved than the parenchyma, the pelvic type. In some there is obstruction at the uretero-pelvic junction and in others obstruction lower down. Changes in the wall of the kidney pelvis occur. There may be small nodules due to lymphoid infiltration, metaplasia of epithelium and leucopeplakia.

(c) The changes in this type are of equal intensity in the kidney pelvis and parenchyma. Destruction of the parenchyma with formation of multiple abscess cavities occurs. There is an increase in the peripelvic fat invading the hilum and compressing the kidney pelvis. The capsule of the kidney may be thickened and the perirenal fat adherent. There is dilatation of the kidney pelvis and calyces at the expense of the parenchyma, due either to obstruction to outflow or to atony of the wall of the ureter and kidney pelvis as a result of inflammation.

The following observations on the pathology of such conditions in pregnancy are based on the post-mortem findings in 8 women who died of "pyelitis of pregnancy". A constant feature in all was the presence of abscesses in the kidney substance, with only moderate dilatation of the pelvis and ureter. The condition therefore corresponds to either the acute pyelo-nephritis or subacute pyelo-nephritis of the parenchymatous type. The condition was bilateral in 4, right-sided in 3 and left-sided in 1.

Fig. 98 is a photograph of the kidneys in the only acute fulminating case (case sheet no. 16) in the series. It shows very strikingly the multiple abscesses scattered

throughout the right kidney. The whole kidney is very much enlarged. The condition constitutes an acute necrosis of the kidney, and microscopic sections of it confirm this. Fig.99 is a microphotograph of a transverse section of a papilla. It shows that some of the collecting tubules are packed with pus cells, while others are unaffected. Fig.100 is a microphotograph of one of those tubules cut longitudinally and shows that it is filled with pus throughout its length. Fig.101 is a microphotograph of the same area of the kidney under lower magnification, showing those dilated tubules filled with pus cut transversely and longitudinally. They extend upwards into the cortex, where the convoluted tubules and the glomeruli are involved in the inflammatory process. This appearance is held by many to be diagnostic of ascending infection, but in this case the infection was certainly haematogenous. The patient had been ill only for 12 days with acute toxæmia. The clinical features all pointed to a septicæmic condition. The organism was found in the blood on the fifth day of the illness and was cultured from the spleen and heart blood at post-mortem examination. The right kidney pelvis and ureter were only slightly dilated and inflammation of them was slight.

In the second unilateral right-sided case, the cause of death was peritonitis, due to perforation of the ureter at the level of the pelvic brim by ulceration of a calculus through its wall. There was a subacute pyelonephritis of the right kidney with marked involvement of the kidney pelvis and ureter, the wall in both being thickened. The condition had been present for some years.

In the third unilateral case a subacute pyelonephritis was present with an adherent capsule and only moderate dilatation of the kidney pelvis and ureters. At post-mortem examination in this case an abscess was found under the liver, coming from the gall-bladder. There was also massive collapse of the lung. The patient had been ill for many weeks and was very emaciated.

In the only left-sided case, death was due to pulmonary embolism on the tenth day postpartum. Abscesses were present in the left kidney and there was fairly marked involvement of the kidney pelvis and ureter. The patient was admitted as a case of antepartum haemorrhage and was found to be in labour on admission. The premature labour was due to the toxæmia from the kidney condition. Despite the severity and acuteness of the kidney condition, the

temperature was normal from the third day postpartum, and the patient had been allowed up when sudden death occurred, the origin of the embolus being the renal vein.

There were 4 cases of bilateral involvement.

In one, death occurred after a prolonged illness resulting in emaciation. She was found to have a generalised septicaemia, basal pneumonia and abscesses in both kidneys. There was moderate dilatation of both ureters and kidney pelvis and they were affected to some extent by the inflammation.

The second case was septicaemic in type from the beginning. Gallstones were found with empyema of the gall-bladder, which was probably the primary source of the infection. Abscesses were found in both kidneys and there was only moderate dilatation of the kidney pelvis and ureters.

The third case had a long history and was very emaciated. Abscesses were found in both kidneys and there was fairly extensive dilatation of both ureters. Fig.16 is a photograph of the kidneys and ureters in this case and Fig.102 is a microphotograph of a transverse section of the wall of the right ureter, showing destruction of mucosa and muscular layers, with marked oedema. In cases of this type

with extensive involvement of the wall, the tone of the ureter is permanently affected, although in the absence of obstruction to outflow, the ureter may function fairly efficiently.

The fourth case is of particular interest, case sheet no.17. She was admitted with a history of right-sided "pyelitis" of 2 months' duration, with normal temperature and pulse rate. The chart shows that she developed a high temperature and organisms were grown on culture from the blood. She also developed profuse haematuria and pain over the left kidney. Labour followed immediately and the patient died on the third day postpartum. Fig.103 is a photograph of the kidneys in this case. The right kidney shows a typical subacute parenchymatous pyelo-nephritis. It is enlarged and there is thickening of the capsule, with the perirenal fat adherent and indurated. At the lower pole the small abscesses which are scattered throughout the whole substance of the kidney can be plainly seen. The kidney pelvis is only moderately dilated and is filled with blood clot. Fig.104 is a microphotograph of a sagittal section of the right ureter, showing that it is grossly infected. Other sections demonstrate that the ureter is infected throughout

its length but below the pelvic brim only to a mild degree. This is characteristic of most of the cases. The left kidney shows a fan-shaped area of infection with its apex at the tip of one of the papillae. Otherwise the left kidney is normal. Sections of the papillae in the affected area of the left kidney show exactly similar appearances to those in Figs. 99 and 100. Fig. 105 is a microphotograph of a section through the wall of the left kidney pelvis, showing slight infection indicated by round-celled infiltration and oedema.

The fan-shaped area of infection seen in the left kidney with pus in the collecting tubules has been held to be characteristic of ascending infection but in this case the blood culture was positive at the time of onset of the left-sided symptoms and the kidney pelvis and ureter on the left side were only slightly involved. Considering this evidence together with the clinical features, a haematogenous spread of infection from the right kidney to the left is almost certain. The organisms were excreted by the left kidney into the kidney pelvis where the stasis was sufficient to allow them to proliferate and ascend back into the kidney substance. The organisms did not come from the bladder.

Even in the fulminating case the tubules were

packed with pus, as I have shown in Fig.99. This could hardly have been an ascending infection, as the bladder was scarcely affected and in the early stages the bladder urine contained only a few pus cells and organisms. In all the 8 cases described, the kidneys showed more or less the same features.

The kidneys in other 4 cases have also been examined. All 4 had previously suffered from pyelitis of pregnancy. One died of heart disease several years later and one of eclampsia in a subsequent pregnancy; one had the right kidney removed for ureteral stricture and the other also had the right kidney removed because of haematuria. The appearances in all the kidneys were typical of subacute or chronic pyelo-nephritis. Typical shrunken areas were seen in the cortex. Fig.106 is a photograph of the kidneys of the patient who died of heart disease; the clinical details are given in case sheet no.18. The case was a typical example of a right-sided "pyelitis" spreading later to the left side. The photograph shows clearly the healed abscesses, especially in the right kidney which is small and contracted. Fig.107 is a microphotograph of a small area of the right kidney. It shows fibrosis of glomeruli, which are

clumped together due to massive destruction of tubules. There is also a thickening of vessels and round-celled infiltration. These appearances are typical of old-standing chronic pyelo-nephritis. This patient died of heart disease and, despite such extensive kidney lesions, showed no sign of renal insufficiency. She was observed and had a complete urological investigation during her only pregnancy when she had the attack of pyelo-nephritis. It was regarded as being a typical case of severe pyelitis of pregnancy. She made a good recovery following delivery and cystoscopic examination performed 2 months postpartum showed no delay in excretion of indigo carmine, although the concentration of the dye was poor.

The condition then in fatal cases is really a parenchymatous pyelo-nephritis and in the 4 cases which had recovered from an attack of pyelitis of pregnancy the same type of lesion was found. In my opinion pyelitis of pregnancy is always a pyelo-nephritis, in some cases the kidney substance being more affected and in others the renal pelvis and ureter. To accumulate sufficient numbers of specimens to prove this would not only be very slow but would only represent the more severe forms of the disease, as a

rule. Careful urological examination in pyelitis of pregnancy supports this view that the kidney substance is involved.

Urological Findings.

The methods used to study the effect of infection on the urinary tract are the same as those already given in detail in Chapter III — chromocystoscopy, catheterisation of ureters, urea concentration of the urine from separate kidneys, McLean's urea estimation and intravenous pyelography. Gross infection of the upper urinary tract may be present without symptoms, so that to obtain accurate knowledge of the extent and distribution of the infection, a urological examination is essential. The conclusions arrived at in this section have been based on the findings in 121 cases in which catheters have been passed into both ureters to ascertain exactly whether infection was present or not, and, if present, its extent. In 60 cases the infection was bilateral and in 61 unilateral.

In 118 of those cases chromocystoscopy was done and the results are shown on Table XI.

TABLE XI.

Degree of Stasis	Right-sided Infection			
	Primigravidae		Multiparae	
	Right side	Left side	Right side	Left side
Marked	5	} 74%	6	} 48.4%
Moderate	15		10	
Slight	6	4	16	4
None	1	22	1	28

Degree of Stasis	Bilateral Infection			
	Primigravidae		Multiparae	
	Right side	Left side	Right side	Left side
Marked	6	3	4	1
Moderate	14	11	14	11
Slight	6	9	9	5
None		3	4	14

In cases of right-sided infection, moderate or marked stasis occurred in 74 per cent. of primigravidae and 48.4 per cent. of multiparae. In a series of uninfected cases, page 94, moderate or marked stasis occurred on the right side in 50 per cent. of primigravidae and 14.2 per cent. of multiparae.

Therefore, where there is urinary infection, the incidence of stasis is greatly increased in both primigravidae and multiparae.

In cases of bilateral infection, the figures for the incidence of moderate or marked stasis on the right side are 76·9 per cent. in primigravidae and 58 per cent. in multiparae, comparable to the findings in cases where the right side only is infected. As regards the left urinary tract, in bilateral infection 53·8 per cent. of primigravidae and 38·7 per cent. of multiparae showed moderate or marked stasis. Where the right side only is infected, the table shows that only slight stasis occurs in the left urinary tract in both primigravidae and multiparae.

In a number of cases where there was no stasis the concentration of indigo carmine was poor, indicating involvement of the kidney substance. On the right side also in some cases of marked delay emptying of the upper urinary tract, by passing a catheter to a point above the level of the pelvic brim, caused the dye to come through in good concentration, showing that kidney function had been improved by the relief of tension, and that the kidney was not seriously damaged. In other cases, in spite of relief of tension, the concentration of dye remained poor, indicat-

ing more damage to the kidney substance.

Where the infection was confined to the right side, the function of the left renal tract was usually very good, which may be explained by a compensatory overactivity or by the fact that the left renal tract being so efficient has not become infected.

The indigo carmine test gives a very good indication as to whether the lesion is unilateral or bilateral, without the necessity of passing a ureteral catheter. This is very valuable as it is undesirable to pass a ureteral catheter into an uninfected ureter through an infected bladder. The test is not wholly reliable as it fails to detect cases with little stasis and mild infection. Out of 66 cases diagnosed as right-sided by this method of chromocystoscopy, 11 proved to be bilateral on ureteral catheterisation. They were all cases of mild infection with very little stasis. Out of 52 cases diagnosed by chromocystoscopy as bilateral, 5 were found to be only unilateral on ureteral catheterisation, in all of which there was moderate delay in excretion of the dye from the left side, so that bilateral infection was diagnosed. In 3 there was more dilatation than usual of the left urinary tract seen on

intravenous pyelography, which explained the delay at the left side. The dye was in good concentration when it did appear and before the result of the bacteriological examination was known I had concluded that the left kidney substance was not involved in the infection. Despite the minor limitations of chromocystoscopy in the exact diagnosis of infection, it is invaluable because of the information it gives regarding stasis in the ureter. In cases where drainage by indwelling ureteral catheter is contemplated, it is a guide in determining whether both tracts or only one should be drained.

A comparison of the concentration of urea in the urine from both kidneys is important in estimating the amount of involvement of kidney substance. If the infection is confined to one side, the concentration of urea is always lower than at the other uninfected side. Sometimes the difference is very great. When the infection is bilateral the concentration of urea is more affected on the right side, corresponding to the greater degree of stasis on that side. In some cases, especially left-sided infections, there may be very little disturbance of the kidney's power to concentrate urea. Probably, therefore, the

infection in such cases involves the kidney pelvis and ureter much more than the kidney substance.

In 22 cases of bilateral infection the average concentration of urea at the right side was 0.87 per cent. and at the left 1.17 per cent. In 29 cases of right-sided infection the average concentration of urea at the right side was 0.78 per cent. and at the left 1.35 per cent. In pyelitis of pregnancy, therefore, the concentration of urea is always lower on the right side, except in a very few cases where the infection is confined to the left side and the right renal tract is undilated. In this case it may be slightly lower on the left side, but is never affected to the same extent as in right-sided infection. This is in agreement with the lack of stasis in the left renal tract and also the infrequent involvement of the kidney pelvis and calyces in dilatation of the left tract.

In 31 cases on the grounds of the urea concentration findings the condition was diagnosed as confined to the right side. In 2, this proved to be wrong. On the left side in both cases, there was no stasis, the concentration of indigo carmine was good but there was also a mild infection present. A pyelogram taken in one of them showed that

there was practically no dilatation. In 25 cases the infection was correctly diagnosed as bilateral, on the grounds of the urea concentration findings.

McLean's urea concentration test was performed in 19 cases where the infection was known to be bilateral, and with one exception, the maximum concentration of urea was less than 2 per cent. The same test performed in a large series of unilateral cases showed a concentration of over 2 per cent. in all cases. This is a very good check as to whether the condition is unilateral or bilateral and has the advantage that it does not require cystoscopic examination.

The estimation of the urea and non-protein nitrogen content of the blood is of little value in assessing the amount of kidney damage. In 7 very severe cases of pyelitis of pregnancy the blood urea was within normal limits, between 20 and 40 mg. per 100 cc. In one the non-protein nitrogen was 47 mg. per 100 cc., only slightly above the normal. Gibberd (1932) considers a rise in the blood urea as an indication for termination of the pregnancy, but in my experience pregnancy has to be terminated often in cases where the blood urea is normal.

In 22 out of 41 cases in this series in which intravenous pyelography was done, dilatation and infection were confined to the right urinary tract in all but 3, in which the left urinary tract was infected also, although practically undilated. In the remaining 19 cases there was dilatation on both sides but less on the left. The infection was bilateral in 16 and confined to the right side in 3, so that on the left side in 3 cases there was dilatation without infection. As a rule therefore, where there is bilateral dilatation there is also bilateral infection but infection can occur where there is little dilatation and there may be dilatation present without infection.

There is very little difference in the pyelograms from infected and uninfected cases, except that in cases of bilateral infection there is more dilatation of the left urinary tract. It is impossible to diagnose the presence or absence of infection from a single pyelogram, although a series taken after injection of uroselectan may give evidence of disordered kidney function from which the presence of infection may be deduced. It must be remembered, however, that occasionally in uninfected cases marked disturbance of kidney function can occur, as shown in

Chapter III.

In many cases of pyelitis of pregnancy the kidney function is relatively more affected than the ureteral function, so that the uroselectan is excreted slowly by the kidney and carried away relatively quickly by the ureter. Therefore at no time during the examination is the shadow of the kidney pelvis and ureter dense. Fig.108 is an intravenous pyelogram in such a case. The infection was bilateral and the dilatation approximately equal on both sides and moderate in degree. The shadow on the right side, however, is very much fainter than on the left and did not improve in intensity at any time during several hours after injection of uroselectan.

When the infection has persisted for some time there may be an increase in the density of the shadow obtained on intravenous pyelography, due to delay in excretion from the ureter which has now become more affected. In cases of bilateral infection a very dense shadow is frequently obtained on the left side, since there is sufficient delay in excretion from the ureter without too much interference with kidney function. This combination of circumstances is the optimum for obtaining dense pictures of the

urinary tract in intravenous pyelography, and Fig.109 is an example of the excellent picture obtained by this method in a case where these conditions are present in the left urinary tract.

Intravenous pyelography helps to explain why in some cases of pyelitis severe pain over the kidney or ureter is present, while in others the local symptoms are slight and general toxæmic symptoms predominate. In the cases with severe pain, dilatation of the urinary tract is usually very moderate in degree and there may or may not be delay in appearance of the shadow. Fig.110 is a pyelogram in an acute bilateral case with severe pain, occurring in the sixth month of pregnancy. It shows only moderate dilatation of the right tract with acute kinking and very slight of the left, and as a dense shadow has been obtained in 20 minutes there is little interference with kidney function. Fig.111 is a pyelogram from a patient with an acute right-sided pyelitis accompanied by severe pain, which shows moderate dilatation of the right tract, with acute kinking of the ureter and no dilatation on the left side. In both of these cases the tone of the ureter was probably good and the intense pain due to spasm of the ureter. In spite of the

apparent severity of the attack, the kidney function was not much affected as in both cases a very satisfactory shadow of the kidneys and ureters was obtained in 20 minutes after injection of uroselectan. The infection apparently primarily induces spasm and intermittent blocking at the kink in the ureter. A catheter inserted into the ureter to a point above the level of the pelvic brim immediately relieves the pain, as in cases of acute kidney pain where the urine is sterile, indicating that the disordered ureteral function is caused by obstruction at the pelvic brim.

In other cases where the attack is equally acute and accompanied by severe pain, there may be great difficulty in obtaining a shadow of the kidney pelvis and calyces, due to more extensive involvement of the kidney substance.

Fig.112 is a pyelogram in Mrs. D., case sheet no.18, which shows only a faint shadow of the calyces of the right kidney 20 minutes after injection of uroselectan. The intensity of the shadow did not improve in later plates. This patient died of heart disease 4 years after this attack of pyelitis of pregnancy and a photograph of the kidneys in Fig.106 shows that the right kidney has been the seat of multiple abscesses, which explain the gross impairment of

function, indicated by the pyelogram.

In the cases with slight or no local symptoms, more dilatation is usually found. Those are cases where either there was very marked dilatation before the onset of infection or where the dilatation, comparatively slight in the acute stages, has been increased by the infection, as a result of the continued action of the inflammation on the structure and tone of the ureteral wall. Fig. 113 is a pyelogram taken $1\frac{1}{2}$ hours after injection of uroselectan in a case of bilateral pyelitis with no local symptoms. The function of the right kidney is so poor that no shadow is seen. On the left side there is gross dilatation of the calyces, kidney pelvis and ureter, only clearly defined after this interval.

Schumacher (1931) finds that intravenous pyelography shows no difference between the urinary tracts of healthy pregnant women and of those suffering from pyelitis of pregnancy, except that the pelvic portion of the ureter is much more often dilated in infected cases. He states that only in very severe cases does the toxin produce marked atony of the wall of the ureter. Jacobi (1932) finds that characteristic changes are not always recognisable in intra-

venous pyelograms in cases of pyelitis. Held (1932) finds intravenous pyelography invaluable in coming to a diagnosis, as it is a good test of kidney efficiency. In my opinion, although intravenous pyelography is very useful where cystoscopic examination is undesirable, it is not so reliable as chromocystoscopy combined with ureteral catheterisation.

Signs and Symptoms.

The following description of the signs and symptoms is based on a study of 390 cases of pyelitis of pregnancy. In order to obtain an accurate idea of the relative frequency of the various signs and symptoms met with, the first 156 cases have been used for analysis, as they represent an unselected group, being the total number in 1,000 consecutive cases admitted to the antenatal wards. Many of the remaining cases were specially selected for study because they were ill or presented some feature of interest, many of them being sent by colleagues in other units of the hospital for investigation and treatment.

It is customary to divide cases of pyelitis of pregnancy into two groups, acute and chronic, according to the severity of the urinary symptoms. This classification

is very unsatisfactory as, in the first place, many cases classified as chronic when first seen, would probably have been classified as acute if seen earlier in the illness and, secondly, those classified as chronic but definitely at the beginning of the illness differ from the acute type only in the absence of severe kidney pain. They are acutely ill but general symptoms predominate. I have classified the cases in this series according to the severity of the illness, as severe and slight. Severe cases include both types, which I prefer to call "renal", where kidney pain is severe, and "toxic", where symptoms of general toxæmia predominate.

In this series 90 or 57 per cent. were classified as severe, the incidence in primigravidae being 76·3 per cent. and in multiparae 49·5 per cent. In a typical severe case of the renal type, the patient is seized with an acute attack of pain in the costovertebral angle with great tenderness, most often on the right side. At this stage there is often marked rigidity of the abdomen and if the kidney can be palpated, it is enlarged and tender. The temperature is usually high — 102° to 104° — with wide oscillations and there may be rigors. The pulse rate is increased to 110 to 130 per minute. The cheeks are flushed

and the tongue dry and coated. Respirations are usually increased in rate and shallow, and there may be pain on inspiration and short cough. The patient may therefore present many of the features of a lobar pneumonia. Sickness and vomiting are often marked. There is usually frequency of micturition and sometimes, although not often, pain during or at the end of micturition. In some, the bladder symptoms precede the onset of kidney pain; in others, the reverse is the case. Bladder symptoms coincided with or preceded kidney pain in 76, and followed the onset of kidney pain in 18. There were no bladder symptoms in 62 or 39 per cent. The time of onset of bladder symptoms is of no significance in determining whether the infection is ascending or descending. As a rule during pregnancy, the lack of involvement of the bladder, even where the kidneys have been heavily infected for months, is a striking feature. The patient is usually able to empty the bladder completely, in marked contrast to the findings in the puerperium, where residual urine is very frequently found in the bladder and may explain the susceptibility to cystitis in the puerperium. In some of these cases the renal symptoms disappear very quickly, changing the clinical picture to that presented by

the toxic type. Where the case is of the toxic type from the beginning, the onset is more gradual and the striking features are nausea, vomiting and slight jaundice, and subsequently loss of weight and secondary anaemia. The temperature, although sometimes high, is more usually between 99° and 100° and there are often intermissions of some days' duration. The pulse rate is usually maintained at a high level, 100 to 120. The symptoms indicate septic absorption as the result of poor drainage. There is usually slight tenderness over the kidney region and in some in the iliac fossa. There may be tenderness in the iliac fossa and none over the kidney. The presence or absence of pain and tenderness along the urinary tracts is no real indication as to whether infection is present or not. Symptoms may be completely absent in cases where drainage is good or in cases where the flow of urine has almost stopped and the tract has become converted into a pus sac, due to the poor tone of the kidney pelvis and ureter. A pyelogram in Fig. 114 is from a typical toxic case, in a II-para. The first pregnancy had terminated in the eighth month, the child being stillborn, as a result of what was diagnosed as hyperemesis gravidarum, but in reality was a toxic pyelitis.

In the second pregnancy the striking features were again vomiting and loss of weight, with no renal symptoms.

Intravenous pyelography shows enormous dilatation of the calyces, kidney pelvis and ureter on both sides. The pyelogram, taken 2 hours after injection, shows that the shadow on the right side is still faint. The patient was enabled to go to full time by repeated treatment with ureteral catheters, on each occasion large quantities of pus being evacuated from both sides.

Based on the history and clinical examination, the following table shows the relative frequency of infection of the renal tract on the two sides.

Right-sided alone	- - - - -	76 or 48.7%
Left-sided alone	- - - - -	25 or 16.2%
Bilateral with symptoms	- - - - -	36 or 23%
Latent (with no renal symptoms whatsoever)		19 or 12.1%

To test how far this classification was accurate, 30 cases were examined urologically and the findings compared with the clinical.

<u>Clinical</u>		<u>Urological</u>	
Right-sided	13	Right-sided	4, the other 9 bilateral.
Left-sided	6	Left-sided	0, the 6 all bilateral.
Bilateral	11	Bilateral	8, the other 3 right-sided only despite the presence of pain and tenderness on the left side.

Clinically the infection is diagnosed as bilateral in 36 per cent. of cases whereas actually, as proved by urological examination, it was bilateral in 76 per cent.

In the rest of the series the distribution of the infection on clinical grounds was right side alone in 116 or 45.4 per cent., left side alone in 24 or 10.4 per cent., bilateral in 54 or 23.5 per cent. and latent in 37 or 20.7 per cent. Similar findings as before were obtained when the cases were examined urologically. In 34 clinically right-sided cases the diagnosis was found to be wrong in 18, in 4 clinically left-sided it was wrong in 2, and in 19 clinically bilateral it was wrong in 5. Therefore bilateral infection of the kidneys is almost twice as common as appears from clinical examination alone. This seems to have been overlooked by previous investigators. Albeck and Lenharz (1931) in a series of 129 cases, state that the

infection was right-sided in 67 or 51 per cent., left-sided in 26 or 20 per cent. and bilateral in 36 or 27·8 per cent. These figures correspond fairly closely to the figures in my series diagnosed on clinical grounds alone.

If, therefore, the clinical features alone are relied upon, apart from the extent of the infection not being appreciated, its presence may be missed entirely if there are no urinary symptoms.

Diagnosis.

As has been indicated above, the condition is frequently wrongly diagnosed. In the first series of 156 cases of pyelitis of pregnancy, 98 or 60·8 per cent. were wrongly diagnosed. In some, this was due to absence of symptoms referable to the urinary tract and in others, the symptoms were so slight as to be missed. The following are the different diagnoses under which the cases were admitted to hospital.

Pyelitis	63	Placenta praevia	3
Albuminuria	31	Appendicitis	2
Hyperemesis	11	Influenza	2
Premature labour	9	Hydramnios	2
Contracted pelvis	7	Renal stone	1
Debility	6	Cystitis	1
Pleurisy	6	Haematuria	1
Threatened abortion	6	Oedema	1
Cardiac disease	4		

The most frequent mistake is to diagnose the condition as albuminuria. In such cases renal symptoms are absent and there are loss of weight, sickness, anaemia, little if any oedema, no rise of blood pressure and only a haze of albumen. The question of whether albuminuric toxæmia and pyelitis can occur together has already been discussed on page 191, where it is shown that out of 135 cases of albuminuric toxæmia in the series of 1,000 cases, 9 or 6.6 per cent. had pyelitis. Those cases were all old-standing conditions and were really cases of albuminuric toxæmia occurring in women who had chronic urinary infection.

In the pyelitis cases, 12 had oedema and 4 had rise of blood pressure. Only one case which had oedema had also a rise of blood pressure. She had had a pyelitis with a previous pregnancy and during the present pregnancy was admitted with pyelitis and slight antepartum hæmorrhage. The pyelitis may have caused a chronic kidney lesion. In 3, the oedema was due to anaemia and cardiac disease. In other 3 admitted near full time the slight oedema might have been due to pressure. In 2, the oedema was due to varicose veins and in the remaining 3, in which the oedema was slight,

there was no obvious cause. In the 4 cases with raised blood pressure there was the one already mentioned, 2 with very long histories of urinary infection which now showed symptoms of chronic nephritis, one of them being admitted in uraemic coma. The fourth case, Mrs. W., case sheet no.19, was very unusual, as she was admitted with an acute attack of pyelitis of renal type. There was blood in the urine, the albumen registered 10 parts Esbach and the blood pressure was not raised. Later in the pregnancy she developed pre-eclamptic toxæmic symptoms and her urinary infection became less. In a subsequent pregnancy she had eclampsia and finally uraemia. Out of 156 cases of pyelitis of pregnancy, this was the only patient who had oedema and marked albuminuria, with an acute primary attack. It is possible that the coliform infection caused a nephritis, although the kidneys may not have been normal before pyelitis developed. None of the others developed albuminuria later in the pregnancy.

Another common mistake is to diagnose the condition as hyperemesis. This is particularly easy in toxic cases where vomiting and sickness are marked, but as those symptoms if due to pyelitis occur in the later months of pregnancy the condition should not be confused with hyper-

emesis, where the symptoms occur in the early months. The following table gives the incidence of those symptoms in the 1,000 cases admitted to the antenatal wards of the hospital.

T A B L E XII.

	Anaemia	Sickness	Jaundice	Loss of weight	Loss of appetite
No infection	45.9%	37.7%	12.3%	17.9%	28.3%
Infection of no or doubtful significance	37.5%	32.3%	8.8%	11.7%	23.5%
Pyelitis	60%	60%	32.7%	60%	62.2%

The incidence of the various symptoms is greater in pyelitis cases than in the rest of the series. The uninfected group includes cases of hyperemesis, anaemia, contracted pelvis and albuminuria. Even so, the incidence of the various symptoms is so much higher in the pyelitis group that their presence should always lead one to examine the urine microscopically for evidence of infection.

There were 6 cases diagnosed as debility, which was really only a symptom of the urinary infection.

Nine were diagnosed as premature labour, where the pain was really renal in origin and consisted of intermittent pain in the back coming round to the front along the line of the ureter. In some cases also uterine contractions actually did occur. The association between renal and uterine colic has been explained in Chapter III.

In the 7 cases of contracted pelvis the presence of urinary infection had been overlooked.

In 6 cases diagnosed as threatened abortion and 3 as placenta praevia the vaginal bleeding was slight and probably the result of the toxæmia from the urinary infection.

In 4 cases diagnosed as cardiac disease the patients had definite heart lesions but the chief cause of the illness was obviously the kidney condition.

In the cases of hydramnios the pain complained of was due to inflammation of the urinary tract, which had been missed.

In those cases diagnosed as renal stone, haematuria and cystitis the true diagnosis depended upon an accurate

urological examination.

Where there are symptoms of acute pain and tenderness, the diagnosis may be in doubt, as the condition may simulate pleurisy, pneumonia or appendicitis. In some cases the differential diagnosis between pneumonia and pyelitis is difficult. In 11 cases out of the total of 390 cases of pyelitis which I have examined, that is 3 per cent., I have come to the conclusion that both conditions co-existed. In 13 other cases there was congestion of the base of the lung but no consolidation. The following case illustrates the difficulty in diagnosis.

left Mrs. H., case sheet no. 20, was admitted in the sixth month of her first pregnancy, complaining of severe pain over the whole of the left side of the abdomen and chest, with extreme tenderness over the left kidney behind. The temperature was 103° and the pulse rate 120. Respirations were rapid and there was a short, dry cough. There were râles and some dulness at the left base but no sign of actual consolidation. There was abundant growth of pneumococci from the sputum and the urine contained blood but no organisms. On the fifth day after admission, the condition having remained unaltered, the pain still very severe, a catheter was passed into the right ureter and almost immediately the pain and tenderness entirely disappeared and, as is seen from the chart, there was a dramatic drop in the temperature, respiration and pulse rates to normal. No evidence of infection of the left kidney was found.

The pain was due to spasm of the left ureter at the uretero-

pelvic junction, probably induced by congestion in the diaphragmatic area from the inflammation of the lung. The condition was probably a pneumonia with associated congestion of the kidney. This patient later developed pyelitis of pregnancy. Helmholtz and Milliken (1923) record 4 cases of pyelitis secondary to respiratory infections in children. They came to the conclusion that the organism infecting the respiratory tract does not act specifically on the kidney but causes a general lowering of resistance, so that the kidney is susceptible to the attack of the coliform organism.

In case 20, quoted above, the kidney condition was secondary to the pneumonia, but more often in this series a congestion of the base of the lung developed secondarily to an attack of acute pyelitis, probably by congestion of the diaphragmatic area.

The treatment in both pneumonia and pyelitis is fairly similar so that a delay of 24 hours in coming to a diagnosis is not vital. It is otherwise with appendicitis where every hour's delay is so serious. The differential diagnosis may be very difficult especially in the later months of pregnancy, when the caecum has been carried higher up into the abdomen. The mode of onset is usually different

in the two conditions, however. In pyelitis it is sudden with a high temperature and frequently a rigor, the maximum point of tenderness being usually in the costovertebral angle. In cases of pyelitis where the acute attack has subsided the point of maximum tenderness may move round to the front and may even be in the right iliac fossa, making the differential diagnosis very difficult indeed. In appendicitis, at the onset the temperature is lower and there is not usually any rigor. As a pelvic appendix in pregnancy is uncommon, tenderness in the right fornix, due to pressure on the inflamed ureter, is held by many to be diagnostic of pyelitis. In my experience this is quite unreliable. The examination of the urine will usually be sufficient to settle the matter, except where appendicitis co-exists with urinary infection and except in extremely rare cases of pyelitis where the urine may appear sterile, due to complete blockage of the ureter. This latter condition has been recorded in the literature but in my series, even where the block was very acute, there was always some evidence of infection on careful microscopic examination. In one case where the right ureter was completely blocked by a renal calculus, the examination of the urine showed a few pus cells and coliform

organisms. If examination of the urine is not sufficient to settle the diagnosis, then the passage of a ureteral catheter is of great value. This is a simple procedure which does not require an anaesthetic and if the pain and tenderness are of renal origin they will be alleviated and in most cases will entirely disappear within a few minutes of the passage of the catheter. This test is particularly useful in cases where the urine is sterile, as it differentiates between pain due to appendicitis and pain due to spasm of the ureter. I agree with Schumacher (1932) that the disappearance of the pain is more complete in cases where the urine is sterile, as some discomfort may persist in cases where the urinary tract is infected. I have encountered only 2 cases of appendicitis in pregnancy. In one, the diagnosis of appendicitis was sufficiently clear to indicate immediate operation. In the other, although there was marked stasis in the right ureter, the pain was not relieved by passing a catheter. Large quantities of mucus were removed from the right ureter through the catheter. This was probably due to catarrh set up by the inflamed appendix which was found to be overlying the ureter. Wade of Edinburgh (personal communication) has described a case in which there was gross

haematuria caused by an inflamed appendix in the same situation.

Course of the disease.

Table XIII is an analysis of the duration of the pyrexia in the series of 156 consecutive cases.

TABLE XIII.

Duration of pyrexia	Less than 1 week	1-2 wks.	2-3 wks.	3+ wks.	None
Primigravidae	19 32.8%	9	1 27.6%	6	23 40%
Multiparae	34 34%	7	2 9.1%	0	55 56%
Total	53	16	3	6	78

In 78 cases there was no pyrexia. In 53 or 34 per cent. there was pyrexia for less than one week. 9.1 per cent. of the multiparae had prolonged pyrexia (1 to 2 weeks or more), while 27.6 per cent. of the primigravidae had pyrexia for a similar period, 6 primigravidae but no multiparae had pyrexia of more than 3 weeks.

The duration of stay in hospital is seen in Table XIV.

T A B L E XIV.

No. of weeks' stay in hospital	Pyrexia				No Pyrexia			
	Less than 1	1-2	2-3	3+	Less than 1	1-2	2-3	3-4
Primigravidae	1	10	4	18-54.6%	3	7	3	12-48%
Multiparae	1	22	8	12-28.0%	3	32	6	13-24%

This analysis confirms the fact that the disease is more serious in primigravidae than multiparae. In the cases with pyrexia 54.6 per cent. of the primigravidae, while only 28 per cent. of the multiparae, were more than 3 weeks in hospital. It is important to note also that in the cases without pyrexia 48 per cent. of the primigravidae and 24 per cent. of the multiparae were more than 3 weeks in hospital. Twelve of the 25 cases without pyrexia, which were longer than 3 weeks in hospital, had a history of an acute attack earlier in the pregnancy which was accompanied by fever. In 3, the condition was an exacerbation of an old-standing pyelitis. Emaciation, vomiting and anaemia were prominent

features in this group. In several cases the stay in hospital was prolonged because of an additional complication such as antepartum haemorrhage or heart disease.

25 per cent. of the patients were readmitted once for treatment and 1.5 per cent. three times, apart from re-admission for delivery.

As practically all the cases were treated on simple medical lines, we see that it is effective in bringing down the temperature to normal within 1 week in 68 per cent. of those admitted with pyrexia. In 7.7 per cent. of cases (6 primigravidae) the pyrexia was prolonged beyond 3 weeks. As the temperature subsided, the pulse rate gradually fell, though less rapidly. The temperature is swinging in character and the pulse rate varies accordingly. As the temperature and pulse rate fall, the pain in the kidney region diminishes but tenderness is usually elicited on palpation after the temperature has been normal for several days. In some cases the persistence of the pain and tenderness is the most troublesome feature in patients who otherwise feel well. In some cases the pulse rate remains raised after the temperature is normal. This is usually due to septic absorption from faulty drainage of the kidney. This

is the toxic type of case, where renal symptoms are absent. All the 6 primigravidae with prolonged pyrexia were seriously ill — 1 had a spontaneous abortion, 4 had the pregnancy terminated before the child was viable, and 1 mother died. The sixth case was treated repeatedly with indwelling ureteral catheters and went to full time.

The urine practically never becomes sterile before the end of pregnancy and exacerbations during the course of pregnancy are common. The exacerbation may occur within a short time of the initial attack or it may occur after the patient has been well for a fairly long period. As a rule, if the patient reaches the 32nd. week without requiring to have the pregnancy terminated, it is unusual for further serious trouble to be encountered. It is evident that in primigravidae the disease is much more severe as a rule than in multiparae. The pyrexia lasts longer and the patients need a longer stay in hospital. This will be confirmed when we consider the end-results of the pregnancy both as regards the mother and the child.

Prognosis.

The extent of the infection in the urinary tracts influences the prognosis. Table XV shows the outlook for the child in a number of cases where the exact extent of the infection was known by urological examination.

T A B L E X V.

	Primigravidae		Multiparae	
	Right side	Bilateral	Right side	Bilateral
Premature or *small child	6 - 28%	17 - 55%	8 - 25.8%	8 - 28.5%
Full time	15	14	23	20

* $5\frac{1}{2}$ lbs. or less.

Where the infection is right-sided, 14 out of 52 or 26.9 per cent. and where bilateral, 25 out of 59 or 42.3 per cent. had a small or premature child. When these are divided into primigravidae and multiparae we see that the outlook is most serious in primigravidae with bilateral infection. 55 per cent. of primigravidae who had bilateral infection in this

selected series had premature or small children. In the other groups the percentage of premature or small children varied very little and was only half this figure.

Prognosis depends to some extent on the treatment. In the analysis of the 156 unselected cases of pyelitis in the 1,000 series, the treatment was on simple medical lines, which will be given in detail later. There were 4 maternal deaths, one of which was really due to cardiac disease, out of 127 cases in which the end-result was known, so that the death rate was 2.3 per cent. In the other group of cases specially selected from the whole hospital for treatment, there were 7 deaths out of 192 cases, or 3.6 per cent. The stillbirth and neonatal death rate for the unselected series was 15.7 per cent. and for the specially selected, 19.7 per cent. Comparing primigravidae and multiparae, there were 4 maternal deaths out of 132 primigravidae or 3 per cent. and 6 out of 187 multiparae, or 3.2 per cent. The stillbirth or neonatal death rate was 25.7 per cent. in primigravidae and 14.4 per cent. in multiparae. The fatal cases will now be reviewed in detail, to ascertain wherein the treatment failed.

Case no.16 was the only example of an acute fulminating pyelo-nephritis, where death occurred within

14 days of the onset of the illness. The toxic symptoms were so marked that the condition was diagnosed as acute yellow atrophy of the liver. There were, however, high temperature, pain over the right kidney region and coliform organisms in both blood and urine. Immediate nephrectomy in this case would probably have saved the patient's life, as the other kidney was sound. Kidd (1920) records several cases of this type where nephrectomy has been successful.

In 4 cases, Nos.17, 21, 22 and 23, the pregnancy was terminated, in 2 spontaneously and in 2 artificially within a few days of the patient's admission to hospital, on account of the extreme toxæmia. All four had been ill for at least 6 weeks before admission to hospital. If they had received the appropriate hospital treatment earlier, the fatal termination would have been avoided.

In case no.24 death was due to peritonitis following perforation of the ureter by a renal calculus. Peritonitis was present on admission and nothing could be done. She had had renal symptoms for several years and had been ill for several months in the present pregnancy.

Case no.25 developed a septicaemia just before labour, the source being a previous cholecystitis. Abscesses

in both kidneys followed and, despite treatment, she died 30 days postpartum. This death could not have been prevented, as the gallbladder condition had caused very few symptoms.

In the remaining 3 cases, delay in termination of the pregnancy in hospital was probably the cause of death. In case no.26 the patient was dismissed in a toxic condition, re-admitted in labour shortly after and died 17 days later. More thorough examination of kidney function would have prevented premature dismissal. Case no.27 had been ill for $2\frac{1}{2}$ months before admission and was very toxic when admitted to hospital, yet she was treated for 6 weeks before induction of labour was considered necessary. She died on the ninth day postpartum and at post-mortem examination, multiple abscesses were found in both kidneys. Case no.28 had been ill for 3 weeks before admission and had prolonged pyrexia and treatment by ureteral catheterisation on two occasions without improvement. She was then given intravenous mercurochrome, after which the urine was loaded with albumen. Labour was induced and she died on the seventh day postpartum.

The only fatality which was quite unavoidable was in case 25 where septicaemia and pyelo-nephritis originated

from a cholecystitis. Therefore, more accurate diagnosis and more prompt institution of the appropriate treatment should make the prognosis, as regards the life of the mother, exceedingly good.

Table XVI shows details of the premature deliveries in the unselected group of 156 cases of pyelitis.

T A B L E XVI.

	Full time	36+ weeks	32-36 weeks	32-weeks	Unknown
Primigravidae	26 - 55.3%	6 - 12.8%	7* - 14.9%	8 - 17%	11
Multiparae	58 - 72.5%	10 - 12.5%	3 - 3.75%	9 - 11.2%	18
Totals	84 - 66.1%	16 - 12.6%	10 - 7.8%	17 1 - 13.4%	29

* 3 babies died before dismissal.

all babies died.

In 66 per cent. the pregnancy went to full time and in 12.6 per cent. the pregnancy lasted 36 weeks or more, so that in 78.7 per cent. the child was sufficiently mature to be unaffected. In 13.4 per cent. the pregnancy lasted less than

32 weeks and all the children were stillborn. In the cases which terminated between the 32nd. and the 36th. week of pregnancy, there were 3 children who died before dismissal from hospital. It has not been possible to find out how many died in infancy from the effect of the pyelitis. It is seen that premature labour is much more common in primigravidae than in multiparae, 44.7 as against 27.5. This agrees with the relative severity of the condition in primigravidae and multiparae.

Table XVII is an analysis of the specially selected series.

TABLE XVII.

	Full time	36+ wks.	36-32 wks.	32- wks.	Total
Primigravidae	40 - 47.4%	12 - 14%	17 - 20%	16 - 18.6%	85
Multiparae	68 - 68.6%	10 - 9.4%	14 - 13%	15 - 14%	107
Total	108 - 56.4%	22# - 11.4%	31x - 16.1%	31+ - 16.1%	192

3 died.

x 7 died.

+ all died.

The stillbirth rate is slightly higher as there were more seriously ill cases in this group. It confirms that there are more stillbirths among primigravidae.

There were 61 stillbirths and neonatal deaths in the 2 series together. In 26 of these cases, the patients had been ill for 1 to 3 weeks before admission and of these, 16 for less than 1 week. Three of those were admitted with haemorrhage due to miscarriage and 3 had severe renal colic and miscarried within a few days of admission. Four were treated for 2 months after admission and would probably have been improved by more energetic treatment such as ureteral catheterisation. Six, who responded well to treatment at first and were dismissed, came back in labour prematurely. Therefore more energetic treatment while in hospital and better judgment about when to dismiss the patient from hospital would have prevented some of the stillbirths.

If we consider the patients who were ill for over 5 weeks at home before admission to hospital, 3 cases died undelivered. In 15, the onset of labour was spontaneous, the patient either being in labour when admitted or going into labour within several days of admission. In 1 case the mother's condition was so serious that labour was induced

immediately and in 2 cases labour came on after the insertion of ureteral catheters. Therefore, where the patient has been ill for a long time before admission, the chances of prolonging the pregnancy are slight. This emphasises what I have already stated in dealing with maternal deaths — the need for earlier admission to hospital and more energetic treatment.

In the cases where the pregnancy was terminated artificially before the child was viable, it was done in the interests of the mother. Where the onset of premature labour is spontaneous, it occurs either at the height of an acute attack, when the uterine contractions are usually induced reflexly by the spastic contractions of the ureter, in which case they can be controlled by the insertion of a ureteral catheter, as will be demonstrated in case no.29, or they occur as a result of profound toxæmia at a later stage of the disease. In those cases a urological investigation instituted in time will usually give valuable information on which to base the prognosis and treatment. Chromocystoscopy will determine whether there is stasis in one or both ureters and passage of ureteral catheters with estimation of the concentration of urea from each kidney will show whether the

kidney substance on one or both sides is seriously involved. As already shown, this point is of great importance. If one kidney is functioning satisfactorily, then by drainage of the other by a ureteral catheter, the toxic condition of the patient can often be rapidly improved. If both kidneys are seriously involved, the pregnancy should be terminated at once. In neglected cases where the infection has been present for several months, treatment by ureteral catheters is disappointing and may induce labour. Intravenous pyelography is also very useful in determining the degree of kidney damage and, even in fairly toxic cases, is safe.

In very ill cases there is a slight rise in the blood urea but, as it only occurs in the terminal stages, it is of very little value in prognosis.

Regarding the cause of death of the child, in most cases it is due to prematurity but a few cases occur where the child dies, although viable. In some cases it is obviously undernourished and suffering from toxæmia. Vozza (1929) states that sometimes the child actually suffers from a coli septicaemia as well as a coliform infection of the gastro-intestinal tract. He also quotes 3 cases of ophthalmia due to coliform organisms, which had been derived

from the mother's urinary tract. Penkert (1933) says that in his opinion, coliform organisms can travel across the placenta and, in support of this, he quotes 2 cases, one of meningitis and the other of profound toxæmia, where the child died 24 hours after delivery.

There is very little in the literature of this country on the stillbirth rate in pyelitis of pregnancy. Gibberd (1932), in a series of 83 cases of pyelitis of pregnancy, found a stillbirth rate of 3.6 per cent. Voza (1929) found premature labour occurred in 25 per cent. of cases, and von Albeck (1931) in 24 per cent. Held (1932) found a foetal death rate of 22 per cent. My figures agree with those figures from the foreign literature, in the high incidence of premature labour and stillbirth in pyelitis of pregnancy.

To summarise the prognosis, it is more serious in primigravidae than in multiparae for both mother and child. It is more serious in bilateral cases than where the condition is confined to one kidney. It is good where efficient treatment is instituted early and where the response is rapid. It is not necessarily bad in the renal type with severe pain but is worse the longer the duration of the acute symptoms.

It is poor in those cases where the pulse rate remains rapid accompanied by vomiting and loss of weight, indicating septic absorption and kidney damage.

Treatment.

The routine treatment in all cases of pyelitis admitted to hospital is as follows. The patient is put to bed and kept warm but no attempt is made to induce diaphoresis. She is confined to bed until the temperature has been settled for a week. In the acute stages abundant fluids are given, at least 100 ozs. in 24 hours in fairly small quantities at frequent intervals. A mixture of potassium citrate and bicarbonate of soda, 40 grains of each, is given four-hourly during the night as well as during the day. When diuresis has been established, nourishing light diet is given. Liquid paraffin is given to secure an easy bowel motion, drastic purgatives being contra-indicated. Morphia is given in the acute stages when the pain is severe and antiphlogistine applied to the kidney region. If the patient becomes sick, the amount of alkali is reduced or may even be stopped. This reduction in the alkalies is found in many cases to stop the vomiting, as they are very nauseating to

some patients. When the temperature has been settled for about 10 days hexamine and acid sodium phosphate, gr.X and XV respectively, are given 4 times a day.

There seems little doubt that the most important single essential in the treatment of pyelitis is abundant fluid intake. As a rule, if the fluid intake in the 24 hours is over 100 ozs. the acute phase of the attack does not last very long. I have tried the effect of varying the amount of fluid in a few cases and in all of them the condition was made much worse by withholding it. This is illustrated by case no.30, suffering from a typical severe attack of pyelitis in which the temperature and pulse rate had settled. For 12 hours before an intravenous pyelogram was taken she had no fluid and, as a result of the deprivation of fluid, there was an exacerbation of temperature and pulse rate, which subsided on giving fluid. On a second occasion fluid was withheld for 9 hours, when a rise of temperature again occurred. I think that abundant fluids are more essential than alkalies, so that if the fluid intake is diminished by vomiting as a result of alkalies, I have no hesitation in reducing or stopping the latter. Crabtree and Prather (1932) stress the value of the early institution of abundant fluids by which

they have greatly lessened the necessity for admitting such patients to hospital. Pugh (1927) goes so far as to state that drugs are of no value, the essential being fluid. Practically every modern writer is in favour of the administration of alkalies in the acute stages. It is sometimes recommended to be taken two-hourly but I find this causes nausea and vomiting. If the alkalies are given at night as well as during the day, there should be no difficulty in keeping the urine alkaline. The mode of action of the alkaline treatment is still not understood. There is no lethal action on the organisms as they usually increase in number, a marked bacilluria with a small number of pus cells replacing the relatively few organisms and abundant pus cells found in the early stages of the attack. According to Lepper (1927), it does not act by reducing acidosis as, in a series of cases examined by ^{her} him, the bicarbonate content of the plasma was within normal limits in pyelitis. He found that as soon as the hydrogen ion concentration of the urine reached 7.4 to 7.6 the symptoms were relieved, and he was of the opinion that this was due to the less irritating action of the alkaline urine on the inflamed tissues. He says that it is possible that the

hydrogen ion concentration of the urine may be important in controlling the rate and force of the muscular contractions by which urine is expelled from the kidney pelvis.

As regards hexamine, it acts by liberating formaldehyde which in 1/20,000 allows very few organisms to grow but only when the hydrogen ion concentration of the urine falls to 4 is the liberation of formaldehyde considerable. If hexamine treatment is pushed to this stage too early, however, the acute symptoms may return, necessitating a reversion to the alkaline treatment. Sexton (1922) advocates hexamine even in the early stages and says he has not obtained good results with alkalies. This is contrary to the results obtained by the majority of workers. William (1928) gives a warning regarding the too prolonged use of alkalies, giving rise to phosphatic deposits in the bladder, which are difficult to dislodge. I have seldom seen this complication during pregnancy but have observed it in the puerperium where the bladder tone is poor.

Regarding the diet, full light diet should be given as soon as possible and far too many patients are allowed to become anaemic and thin from starvation. Unless in neglected cases, the kidney function of at least one

side is usually satisfactory. The toxaemia tends to produce emaciation and everything should be done to combat this tendency. This is referred to in case no.31.

Mellanby and Green (1929) have shown that an adequate supply of vitamins A and D is important as a prophylactic agent against urinary infections. While the lack of those vitamins may be a factor in the production of pyelitis, the fact that the disease occurs in its most severe form in healthy well nourished primigravidae shows that it cannot be the most important factor. Redewill and Potter (1930) also believe in adequate diet in the treatment of pyelitis, stressing the importance of high vegetable protein content, whole wheat bread, milk and lactose. They give no figures, however.

Posture undoubtedly plays a part in many cases. Most patients suffering from pyelitis prefer to lie with the thighs well flexed as this relaxes the psoas muscle and diminishes the compression of the ureter, thus relieving the pain to some extent. Certain patients obtain relief by lying on one or other side, usually that opposite to the one infected. I have found the hands and knees position to be the most beneficial. The reason for this has been

demonstrated by the graphic method in Chapter III. It acts by allowing the uterus to fall forward away from the posterior abdominal wall, the compression of the ureter being thus relieved. The patient is placed in the hands and knees position for 5 to 10 minutes every hour. It is very useful in relieving severe renal colic. At the same time the patient should have massage over the kidney and down the course of the ureter, as it has been already shown that, in the absence of obstruction to the lower end of the ureter, this greatly helps emptying where the ureter is dilated and atonic. Case no.32 shows the effect of this treatment clearly. The hands and knees position with massage was begun on the day indicated on the chart and immediately the pain which had been severe disappeared, the temperature and pulse rate fell and the amount of pus in the urine increased. There had been no sign of improvement until this treatment was begun. Faulty posture may do harm. It is believed by some that the foetal head pressing on the lower ends of the ureters forms an obstruction to outflow and cases have been treated by elevating the foot of the bed. This, I have not found of any service and it is uncomfortable for the patient. A series of 14 cases was

tried on a constant fluid intake, the quantities of urine excreted from the kidneys into the bladder every hour being measured. The foot of the bed was alternately raised and lowered every hour. The quantities of urine passed with the foot of the bed elevated were, on the average, less than with the patient flat. I have seen cases much the worse of having the foot of the bed elevated. This is illustrated by case no.33 where, 3 days after the foot of the bed was elevated, the temperature rose suddenly and acute bilateral kidney pain followed. The temperature kept rising until it was 104° , when the bed was put flat and the patient very quickly felt better and the temperature fell. The improvement was accelerated by insertion of ureteral catheters. Dodds (1932) claims improvement by raising the foot of the bed and placing the patient on the face, but gives no figures. In my opinion the ureters are so atonic in many cases of severe toxic pyelitis of pregnancy, that it seems unreasonable to expect improvement by making them act against gravity, more especially as there is no compression of the ureters at their lower ends.

Vaccines, bacteriophage, colon lavage and feeding with acidophilus milk have all been advocated but no

convincing proof of their value has been brought forward.

For some years urologists have advocated lavage of the kidney pelvis and drainage by indwelling ureteral catheter in persistent infection of the urinary tract. This method has also been advocated in pyelitis of pregnancy, but there are no publications on the results in this country. Numerous articles have appeared, however, in the Continental and American literature. Garipuy and Martin (1926) advocate catheters but give no statistics. Pugh (1927) states that the larger the catheter inserted, the shorter the disease, and performs meatotomy when necessary. In a series of 15 cases treated by drainage, 14 cleared up. Morphine may be necessary after passing the ureteral catheter for the initial discomfort. Sexton (1922) also quotes brilliant results with catheters, and advises their use in all cases where the temperature does not settle within a few days. He says that the striking effect of a single lavage shows that obstruction and not infection has to be overcome, but in my series I have not found this to be the case, a single lavage having no permanent effect. Misrachi (1931) advocates lavage with silver nitrate in order to stimulate the kidney pelvis to contract. Sennewald (1928), on the other hand,

recommends bland fluids and not silver nitrate as he considers it too irritating. He says that catheters should not be left in too long as they irritate the tissues and may cause haematuria. Crabtree and Prather (1932) are of the opinion that catheters are never necessary and that, although temporary improvement may occur while the catheter is in position, no permanent benefit results. As soon as the catheter is removed the condition relapses. The workers on this subject in pregnancy either advocate whole-heartedly or utterly condemn this method of drainage by ureteral catheters.

Instrumentation in the acute stage of an infection is usually held to be contra-indicated but, as the obstruction to outflow by the pregnant uterus is so important a factor in the production and persistence of urinary infection, I have given this method an extensive trial. The following is a review of 148 cases of pyelitis of pregnancy, where catheters have been passed either for diagnosis or treatment. In 91 of those cases catheters were passed to obtain a specimen of kidney urine for examination or to perform lavage for the relief of pain, catheters not being left in position for more than a few minutes. In 15 out of 16 cases where the pain was severe, it was relieved almost at

once. In 8 there was some degree of pyrexia and in 6 of these at least a temporary fall resulted. In 2 out of 71 cases which were afebrile and had no symptoms, there was a reactionary rise of temperature but in both cases the temperature settled quickly. There is therefore little danger in passing a ureteral catheter in this type of case and where there is pain, lavage may suffice to relieve it. The other 57 cases have been treated by indwelling catheter, for varying periods of time, the details of which are given in Table XVIII.

T A B L E XVIII.

A few hours	24 hrs.	48 hrs.	72 hrs.	Total
Right -- 10	5	3	1	19
Bilateral 7	4	8	2	21
Left -- 0	1	0	0	1
Total 17	10	11	3	

There were 16 cases where the catheters were employed more than once, in 13 of those twice and in 3 three times. In

6, only the right side was drained and in 10, both sides. Altogether, drainage was employed for the right side in 25 cases, for the left side in 1 and for both sides in 31. The results are seen in Table XIX and are classified as (a) very satisfactory, (b) some improvement, (c) no improvement, and (d) worse.

T A B L E XIX.

	Primigravidae	Multiparae	Total
(a) Very satisfactory	24	16	40
(b) Some improvement	6	5	11
(c) No improvement	4	0	4
(d) Worse	2	0	2

In this series of 57 cases there were 20 premature births or 35.1 per cent. In some, however, labour was induced before full time for the sake of the mother as the child was viable. 11 of the 20 premature infants were either stillborn or died within a few hours of delivery, a stillbirth rate of 19.6 per cent. There were 2 maternal deaths, or 3.8 per cent. These

figures cannot be compared with the figures for the first series, as they were all selected for treatment because they were seriously ill and other treatment had failed. In spite of this, the stillbirth and maternal death rates are very little greater. In group (a), those whose response to treatment was very satisfactory, there were 40 cases and all went to term except 3. In 16 of them the response to drainage by catheter was dramatic. In the others, where the improvement was less striking, the patients were not so ill but by catheterisation they were enabled to go to full time in a much better state of health and more comfortably than if they had not been treated.

In group (b), the improvement was classified as moderate since in 8 out of the 11 cases the patient, although improved by the drainage, went into labour with the catheters in position or shortly after their removal. In 7 of these the pregnancy had reached the 36th. week and 6 of the 8 infants survived. 1 child died after birth and the other was not viable. In the ninth case, case no.23, the patient was very toxic on admission but improved with drainage. Abdominal hysterotomy was performed immediately afterwards and the patient died 48 hours later. The other 2 patients

in this group improved and went to term. There is a great danger of bringing on labour in very toxic cases, especially when the pregnancy has reached the 36th. week and special precautions have to be taken to prevent this, which will be described in the section on technique of ureteral catheterisation.

In group (c), the 4 patients were all primigravidae and the cases will be described in detail.

Mrs. H., case sheet no.28, had an acute bilateral pyelitis and was very ill. Ureteral drainage was instituted only after some delay. Catheters were inserted into each kidney on two occasions but were removed because they did not drain well. This was one of the earliest cases treated by this method and the failure was possibly due to lack of experience. Unsuitable catheters and too infrequent lavage may have accounted for the catheters blocking. This patient was treated with intravenous mercurochrome and eventually died of uraemia.

Mrs. O., case sheet no.34, had acute bilateral pyelitis. The ureteral catheters did not drain satisfactorily and the pregnancy was terminated because the patient felt "no life" and no foetal heart could be heard. The child was born alive but died shortly afterwards. The patient made a good recovery. The pregnancy need not have been terminated in this case, if it had been known that the child was alive.

Mrs. P., a primigravida, case sheet no.35, had a bilateral infection with slight tenderness over both kidneys. A catheter was inserted into the right ureter but did not cause the temperature to settle, although it drained very well. In this case if a catheter had been inserted into the left ureter as well, the temperature would have fallen.

The fourth case had been very ill for 6 weeks

before admission and was jaundiced and emaciated. She was passing very little urine. Urological examination showed that there was only slight dilatation of the ureters and very poor kidney function. Catheters were left in position for a few hours but did not drain satisfactorily. Labour was induced.

In this case, both kidneys were the seat of a severe pyelonephritis and drainage in this type of case is of very little value. Even termination of the pregnancy may not be of benefit.

There are 2 cases in group (d), those who were definitely worse after treatment, and in both cases this was due to faulty technique, as they were among the first cases treated.

The technique now employed is described below. An anaesthetic is required very seldom but extreme gentleness is necessary as most of the patients are seriously ill and very sensitive to pain. Restlessness may make cystoscopy rather difficult and it is very important to gain the confidence of the patient. This is emphasised by the comparative ease with which a second cystoscopy is performed when the patient has had relief of pain from the first. The bladder is usually only slightly involved in the infection, so that its capacity is good and visualisation is easy. The most suitable catheters for continuous drainage are nos. 12 and

14 (F), and for routine diagnosis and lavage of the kidney pelvis no.10 (F). The advantage of a no.12 catheter in continuous drainage is that it does not occlude the ureteral orifice completely and allows a ureter which is active to expel urine past it into the bladder. On the other hand, the wider catheter no.14 does not block so readily with pus but has the disadvantage of occluding more completely the ureterovesical opening and may therefore cause discomfort by stretching it. Where the ureter is wide and atonic and filled with pus, the wider catheter is more suitable, while in others where the ureterovesical orifice is relatively narrow or where the ureter is only moderately dilated and of good tone or where the pus is thin, the narrower catheter is more suitable. Catheters must be of the best quality to withstand the constant action of the urine and should be discarded at once when frayed on the surface, as any roughness of the surface will cause trauma. The tip of the catheter is well lubricated with K.Y. jelly before insertion. Flute-shaped catheters with a terminal eye and two lateral ones are essential; otherwise blockage may occur. The three openings ensure that in whatever position the catheter is lying in the ureter, one is always free to drain. Lack

of knowledge on this point accounts for several failures to drain in the early cases quoted. If there is any narrowing of the intravesical portion of the ureter a small olivary tipped catheter is passed first, followed by catheters of increasing diameter till the one desired is reached. As a rule, no further obstruction is encountered till the pelvic brim is reached, when the catheter is felt to stick especially in the right ureter. This obstruction is easily overcome, however, in most cases and on passing the catheter a little higher, urine in large quantities is drained off. Sometimes the urine appears to be under great tension and runs off very quickly, filling a 20 cc. test tube in a few seconds. In most cases obstruction is again encountered 25 cms. from the bladder, due to an acute kink of the ureter just below the kidney pelvis. No attempt should be made to insert the catheter past this kink, because as long as the catheter has been inserted about 20 cms. it is above the point of obstruction in the ureter and it will drain satisfactorily. If attempts are made to force the catheter into the kidney pelvis, serious damage to the ureter may occur at the level of the kink. If the ureter is only slightly dilated, drainage will be intermittent from the

beginning but, where markedly dilated, as much as 200 ccs. may be evacuated in continuous drops before drainage becomes intermittent. In the markedly dilated cases the urine may appear relatively clear to begin with but, towards the end of the evacuation, quantities of thick pus may drain off. The cystoscope is then withdrawn and the catheter secured to the inner side of the thigh with adhesive strapping. When the patient has been returned to bed, a piece of rubber tubing is attached to the end of the catheter and led under the patient's legs over the side of the bed into a bottle. By this means the patient can move about freely in bed. This is very important from the nursing point of view as patients with pyelitis complain greatly of backache if forced to lie on the back for any length of time. The presence of the ureteral catheter does not prevent the patient emptying the bladder naturally of the urine from the other kidney and any which may be expelled past the catheter. Frequently the patient is uncomfortable for several hours after the catheter is inserted and sedatives such as chloral and bromide and, occasionally, morphia are necessary. In some cases catheters have been left in position for as long as 4 days at a time without giving rise to any untoward

symptoms. In other cases, although no pain was experienced for a time, gradually discomfort along the course of the ureters developed. In 2, this discomfort was coincident with the appearance of slight haematuria. In both cases the catheters had been in position for 48 hours without causing any symptoms. The discomfort which then arose was due to the fact that the ureter had so far recovered its tone that it was contracting vigorously and the haemorrhage was the result of trauma from friction against the catheter. In both cases the discomfort and the haemorrhage disappeared on the removal of the catheter, and no harm resulted. This is referred to by Sennewald (1928).

Every four hours 10 cos. of 1/4,000 acriflavine are instilled gently through the catheter to ensure that blockage is not occurring, and the quantities of urine excreted by the kidney are recorded on a chart. I have noticed that when larger quantities of fluid are used for lavage, ureteral colic may be set up from the distension produced. The same quantity which at the beginning of the treatment did not give rise to pain, may later do so owing to the improved tone of the ureter.

The length of time the catheter should be left in

position requires the most careful judgment and every case needs individual consideration. Where the tone of the ureter is good, renal lavage without leaving the catheter in may be all that is required. Where stasis and atony of the urinary tract are moderate in degree, drainage for 24 to 36 hours will usually confer the maximum benefit. Where there is gross dilatation and atony, with large quantities of pus, the catheter may be left in for days without any sign of irritation. The patient's general condition is also a guide as women, who before insertion of the catheters were lethargic, become bright and alert-looking after drainage for 24 hours. The temperature and pulse rate should be carefully watched. They may not fall on the day of insertion of the catheters, due to slight reaction, but should subside the following day if drainage is going to be of benefit.

It is evident that the method requires experience in urological technique and that every case requires the most careful supervision. This explains some of the failures in the early cases. During the last 2 years it has not been found necessary to terminate the pregnancy in any case of pyelitis, where ureteral drainage was employed, except in

a very few cases where the patient was so seriously ill before investigation that it was too dangerous to risk continuation of the pregnancy.

The value of drainage by ureteral catheter is in the relief of obstruction to outflow which it brings about. This acts in two ways, by allowing the ureter to regain its tone and also by increasing the rate of excretion by the kidney. The fact that the tone of the ureter improves has been demonstrated in the description of the technique, and the beneficial effect remains after withdrawal of the catheter, unless the ureter tone is so poor that recovery does not occur. In the very acute cases with severe pain where the tone of the ureter is good, the relief of pain is immediate and this is due to the relief of spasm by decreasing the tension inside the ureter. The improvement in the rate of excretion by the kidney can be shown by the following experiment. A case of bilateral pyelitis in the fifth month of pregnancy was investigated by intravenous pyelography. The first plate taken at 7 minutes after injection of uroselectan showed no shadow of the calyces on either side, although a plate at 25 minutes, Fig.115, showed the right urinary tract down to the level of the pelvic brim and the

calyces on the left side. Intravenous pyelography was repeated immediately after some hours' drainage of both ureters by catheters and on this occasion a dense shadow of the calyces on the right side and a faint shadow on the left side showed in the first plate, Fig.116, taken at 7 minutes after injection. This indicates that improvement in renal function had occurred.

The following case is an example of the improvement which can result from drainage by ureteral catheter.

Mrs. K., case sheet no.36, suffered from an attack of bilateral pyelitis and had been treated for some time by alkalies without improvement. She became restless and drowsy and was sick almost continuously. A catheter was inserted into each ureter and left for 48 hours. The sickness disappeared almost immediately and she became quite bright for the first time for several weeks. The chart shows the immediate drop in the temperature and pulse rate which resulted, and the rise in both which occurred on withdrawal of the catheters. The temperature eventually settled and the pregnancy went to full time.

The following case illustrates the value of ureteral drainage and shows that it may require to be repeated several times during the pregnancy.

Mrs. O., case sheet no.37, admitted in the sixth month of her first pregnancy, with severe right-sided pyelitis. As is seen on the chart, she had cystoscopic examination performed and lavage of the right urinary tract, with no obvious improvement except relief of pain. Six days later, on account of the persistence of fever, a catheter was inserted into the right ureter for 3 days.

This was followed by a fall in both temperature and pulse rate, with marked improvement in the patient's condition. Two weeks later, she developed pain for the first time on the left side and became very lethargic and vomited frequently. She lost weight rapidly. A catheter was inserted into each ureter on this occasion and left in position for 3 days and, as the chart shows, this was repeated on two subsequent occasions as soon as any rise of temperature occurred. The pregnancy went to full time and a live child, 6 lbs. in weight, was born.

This patient undoubtedly would have required induction of premature labour but for the drainage treatment. One year later she again became pregnant and suffered from a mild recurrence of right-sided pyelitis. An intravenous pyelogram during the second pregnancy showed that the left urinary tract was undilated and that the right, although moderately dilated, was functioning satisfactorily.

Where the kidneys are seriously damaged, some improvement in the condition of the patient may be effected by ureteral drainage, even although the pregnancy cannot be carried on until full time. This is illustrated by the case of Mrs. Y.

Mrs. Y., case sheet no. 31, who was admitted in the seventh month of pregnancy suffering from a bilateral pyelitis with extreme emaciation, her weight being 105 lbs. Her normal weight was 136 lbs. Urological examination showed that, although the left kidney was infected, there was no stasis and kidney function was good. On the right side there was extensive involvement of the kidney substance and moderate stasis in the ureter.

She had been on starvation diet before admission but, on liberal diet in hospital, she gained $2\frac{1}{2}$ lbs. in 14 days and improved greatly in strength. The chart shows that pyrexia again developed, with a rapid pulse rate, but subsided after drainage of the right urinary tract with a ureteral catheter for 3 days. Later the pyrexia returned but as the child was now viable, labour was induced by rupture of the membranes. The child survived.

Despite the extensive involvement of the right kidney substance in this case, the patient's condition was greatly improved by the ureteral drainage.

This is also illustrated by the following case.

Mrs. D., case sheet no.38, was admitted complaining of fainting attacks and sickness but no renal symptoms. There was slight pyrexia, as seen on the chart, and rapid pulse rate. Urological examination showed that the right kidney substance was markedly involved and that there was no damming up of pus in the kidney pelvis. The urine contained a few pus cells and numerous coliform organisms evenly distributed through it. A catheter was left in the right ureter for 4 days and the patient's general condition improved immediately, followed later by a drop in the pulse rate.

Where the onset is free from renal symptoms and characterised by vomiting and rapid pulse rate, the kidney parenchyma is more involved than the kidney pelvis and ureter.

The following case illustrates that improvement from ureteral drainage may be only temporary.

Mrs. D., case sheet no.39, suffered from bilateral pyelitis with swinging temperature and rapid pulse rate.

Catheters were inserted into both ureters for 3 days during which time the temperature remained normal and the pulse rate fell from 120 to 100. As soon as the catheters were removed the temperature and pulse rate again rose and when this treatment was repeated 2 weeks later, the same temporary improvement again resulted. It was decided to terminate the pregnancy and the four-hourly pulse rate shows clearly that the pulse rate had dropped from 140 to 110 before the onset of labour. This was probably due to the fact that over 50 ozs. of liquor amni had been drained off, which so altered the shape and size of the uterus that there was less pressure on the ureters. This rapid fall in pulse rate was continued in the puerperium.

In this case the tone of the ureteral musculature was extremely poor, so that it was beyond recovery by such temporary relief as could be afforded by the catheter. The intravenous pyelogram, Fig.117, taken on the tenth day post-partum, shows the extremely atonic condition of the right kidney tract.

The following case shows the necessity for careful supervision during the course of treatment to avoid the danger of leaving the catheter in too long.

Mrs. P., case sheet no.40, in the seventh month of pregnancy with severe right-sided pain due to pyelitis. 3 days later a catheter was inserted into the right ureter which was only moderately dilated. A dramatic fall in the temperature and pulse rate resulted, but 36 hours later severe pain followed the injection of the usual dilute acriflavine for irrigation, and the temperature and pulse rate again rose. They settled after the catheter had been removed. In this case, the catheter should have been removed in 24 hours.

There is no doubt that in most cases termination of the pregnancy has a most dramatic effect in causing improvement in the patient's condition. This is seen most strikingly in patients where miscarriage occurs early in the disease, before the tone of the urinary tract has been impaired by the infection. Such patients usually suffer from very severe renal colic.

Mrs. F., case sheet no.41, is a typical example. She was admitted in the sixth month of her first pregnancy, diagnosed as pneumonia. There was dulness at the base of the right lung with painful and rapid respirations. There was extreme tenderness over the right kidney, and uterine contractions were observed. The temperature and pulse rate were very high. 5 days later miscarriage occurred and, as is seen in the chart, a most dramatic fall in the temperature, pulse and respiration rates resulted. The urine was sterile 14 days after delivery and the patient has had two normal full time pregnancies since; the urine is still sterile.

Mrs. D., case sheet no.29, is a similar example. 8 days after admission the pyrexia was still marked and uterine contractions had developed and there was extreme tenderness over the right kidney. The cervix was dilated and taken up and admitted 2 fingers with the membranes bulging through. At the point indicated on the chart, a ureteral catheter was passed into the right kidney pelvis and urine was found to be under great tension. Almost immediately the tenderness disappeared from the kidney region and the uterine contractions ceased. The catheter was withdrawn in 12 hours and the temperature remained down for 3 days, when severe renal pain recurred, followed by uterine contractions. As the cervix was still dilated, the membranes were ruptured. The delivery was followed by a rapid improvement similar to that following the introduction of the catheter.

This case illustrates the close correlation between uterine contractions and renal colic, and explains why in some cases miscarriage occurs at the height of the acute attack. In this case the introduction of the ureteral catheter certainly stopped the uterine contractions and caused a fall in the temperature and pulse rate similar to that brought about by the termination of the pregnancy. The pain in the kidney region was therefore dependent on the pressure of the uterus at the pelvic brim, although it was probably caused by spasm of the ureter at the ureteropelvic junction. In many cases where premature labour occurs spontaneously, the cause is the profound toxæmia but in others ureteral colic, either spontaneous or induced by the passage of a ureteral catheter or by artificial distension of the urinary tract, may provoke the onset of labour. This explains why some of those cases go into labour following ureteral catheterisation. In normal healthy women near full time, uterine contractions can easily be produced by passing a ureteral catheter and distending the ureter, from which labour may ensue. Both the uterus and the ureter receive fibres from the sympathetic nervous system, so that this phenomenon may be due to reflex stimulation of the uterus by

the ureter along these nerve fibres.

To summarise the treatment, the most important point is prophylaxis during pregnancy and, until we know the exact cause of the primary atony of the ureter, preventive measures consist of abundant fluids to minimise stasis in the urinary tracts, regularity of bowel action with avoidance of drastic purgation, chill and fatigue. Should urinary symptoms develop, a catheter specimen of urine should immediately be examined and, if evidence of infection is present in it, the patient should at once be put to bed and medical treatment instituted on the lines already laid down. If those measures are adopted at the beginning of the illness most cases clear up fairly quickly, although the urine will remain infected until the end of the pregnancy. The indications for urological investigation and treatment are severe pain, persistence of pyrexia for longer than one week on medical treatment, persistence of vomiting which prevents the ingestion of adequate fluids and alkalies, progressive loss of weight and toxic symptoms. Prompt drainage of the urinary tract under those circumstances will allow the pregnancy to continue where otherwise it would require to be terminated and will also minimise the extent of the damage in

the kidney parenchyma. In neglected cases marked improvement may be brought about by ureteral drainage although in some, as has been indicated, onset of labour may ensue, but in very neglected cases it may be better to terminate the pregnancy at once than to attempt treatment by ureteral drainage. In some of those neglected cases, however, where it is considered essential to terminate the pregnancy, preliminary ureteral drainage for 48 hours causes sufficient temporary improvement to minimise the risk of labour. Some of the Continental workers advocate nephrostomy to avoid termination of the pregnancy. Held (1932) considers it is valuable in unilateral cases, but Garipuy and Martin (1926), as a result of their experience in 10 cases, do not favour this method of treatment. Of the 10 cases 4 went to full time, 3 aborted, 1 required to have the pregnancy terminated and 3 required a second nephrostomy. In their opinion, interruption of the pregnancy gives much better results.

As a rule the emptying of the uterus causes an immediate improvement in the patient's condition although, as has been indicated, in neglected cases even termination of the pregnancy may not save the patient's life. The

temperature and pulse rate fall rapidly. The appetite improves and the patient gains in weight. Undoubtedly the safest treatment from the mother's point of view is interruption of the pregnancy, as this minimises the risk of permanent damage to kidney function and the urinary tract. Therefore if the patient does not respond to treatment fairly quickly, it may be wiser to terminate the pregnancy even at the sacrifice of the child, in the hope that the urinary tracts will return to normal and the urine become sterile before a subsequent pregnancy. The same problem of treatment also arises in albuminuric toxæmia, where prompt termination of the pregnancy minimises the risk of permanent kidney damage. The pyrexia rate in the puerperium after a pyelitis of pregnancy is higher than after normal pregnancy, being 28 per cent. (61 cases in a series of 219) but the pyrexia is as a rule of little significance. The cause of the pyrexia was uterine sepsis in 9, uterine together with urinary sepsis in 3, urinary infection in 47, breast condition in 1 and chest condition in 1.

In all the cases of uterine sepsis, the pyrexia was slight and the infection mild. Cases of pyelitis of pregnancy are not particularly liable to puerperal sepsis.

Of the 47 cases with pyrexia due to urinary infection, 32 were due to a prolongation of antenatal pyrexia which lasted only for a few days. In 24 cases the pyrexia lasted less than a week. In 6, although prolonged beyond a week, the condition of the patient was improving. In 15 cases or 6.8 per cent., which had been afebrile before delivery, there was an exacerbation of the urinary infection in the puerperium. In some of these the temperature rose during labour or immediately after, and lasted for varying periods of 4 to 14 days. In 2 the organism present in the urine was isolated from the blood stream, so that the condition was a temporary septicaemia.

This is illustrated by the case of Mrs. W., a III-para, case sheet no.57, admitted in labour, suffering from a chronic pyelitis. She had a forceps delivery and 36 hours later, she had a rigor and the temperature rose to 101° , following on drastic purgation with castor oil. The blood culture was positive and the chart shows that the pyrexia lasted for 8 days but the blood culture, which was repeated every 48 hours, was negative. On the eighth day postpartum cystoscopic examination showed that the elimination from both kidneys was good but that the bladder was very inflamed and there were 3 ozs. of residual urine. On 2 subsequent occasions the temperature rose for 24 hours to 102° with pain in the kidney region but the blood cultures were negative. The identical coliform organism was isolated from the urine, vagina, blood and faeces. In this case the rigor and rise of temperature was due to the presence of the organisms in the blood stream. Whether they gained access from the bowel direct or whether by way of vaginal lacerations is

difficult to tell.

The pyrexia began on the eighth or ninth day of the puerperium in the others, and lasted from 2 days to a week. The pyrexia was symptomless and the patients did not feel ill.

Pyrexia in the puerperium in cases of pyelitis of pregnancy therefore occurs just after delivery, due either to a prolongation of a pyrexia of pregnancy or to exacerbation at the time of delivery, or it may occur later about the eighth or ninth day postpartum, due to exacerbation of a chronic urinary infection. It seldom gives rise to any anxiety under any of those circumstances. The subject will be referred to again in Chapter V on pyelitis of the puerperium.

After-results of Pyelitis of Pregnancy.

The following conclusions are based on personal observation of 208 of the 390 cases of pyelitis of pregnancy, which have been followed over periods of from 1 to 5 years. There were 74 who had no subsequent pregnancy and I have divided them into 4 groups according to their symptoms and the condition of the urine.

(1) Those who were well with the urine sterile. 23 or 32 per cent., 12 primiparae and 11 multiparae. It is difficult to draw conclusions from the multiparae as we had no exact knowledge of the condition in previous pregnancies. 10 of the 12 primigravidae had typical acute attacks of the renal type; 7 of those went to full time so that there was an interval of 3 to 4 months during which time the urine was heavily infected. Nevertheless, the infection had cleared up after the delivery. 10 of this group were subjected to urological examination and some degree of abnormality was found in 4.

(2) Those who were well but with infected urine. 12 or 16 per cent., 6 primiparae and 6 multiparae.

(3) Those who complained of either urinary or general symptoms but in whom the urine was sterile. 16 or 21 per cent., 3 primiparae and 13 multiparae. The symptoms were either pain in one or other kidney region or general ill-health. 12 complained of renal pain, more often on the right side than on the left. In each case chromocystoscopy showed that there was poor concentration of indigo carmine, although delay in excretion occurred only in 3. In

practically every case pyelography showed dilatation of the urinary tract, although never enough to account for the poor urea concentration. The pain induced by the sodium iodide in making the pyelograms was exactly similar to the pain complained of, which proves that it is due to some irregularity in the action of the ureter or kidney pelvis. The poor concentration of indigo carmine indicates damage to kidney function, confirmed by the urea concentration of the urine from separate kidneys.

Eight complained of ill-health with or without renal pain. Four had raised blood pressure and albumen in the urine, and in one there was puffiness of the face and hands. In one the poor health was due to cardiac disease and in 2 anaemia was probably responsible. It is impossible to state definitely that the rise of blood pressure and albuminuria in the case of the multiparae were due to pyelitis as there may have been albuminuria previous to coming under observation, but in 1 primipara, case no.35, the condition certainly began with an attack of bilateral pyelitis. In this case, following the acute attack, there had been marked increased output of urine of low specific gravity and rise of blood pressure. Probably fibrosis of

the kidney substance contributed to the ill-health in this group.

(4) Those who complained of symptoms and in whom the urine was infected. 23 or 31 per cent., 8 primiparae and 15 multiparae. In 21, the urinary infection was of some months' standing before the end of the pregnancy. The symptoms complained of were right-sided pain in 15, left-sided pain in 4, backache in 4, debility and anaemia in 15, raised blood pressure in 1 and haematuria in 1. On urological examination, stasis was found in only 5 cases. This was confirmed by pyelography which showed only minor degrees of dilatation in this group. In one case, however, there was a marked external hydronephrosis and this patient suffered from intermittent haematuria. The urea concentration of the urine from separate kidneys showed that in 50 per cent. of cases the urea at the side on which pain was complained of was diminished. These findings, taken in conjunction with the clinical features, show that not only is there persistent infection of the urinary tract but that there is damage to the kidney substance. The absence of stasis in most of the cases suggests that the infection is persisting in the kidney substance rather than in the pelvis

and ureter. In 2 cases of this type nephrectomy was performed, one because of persistent pain diagnosed as stricture of the ureter, and the other on account of haematuria and in both cases an extensive subacute parenchymatous pyelonephritis was present. This explains the fact that my results of treating those patients by repeated renal lavage were disappointing.

To sum up, in 52 per cent. of cases 1 to 5 years after an attack of pyelitis of pregnancy there was complaint of ill-health or persistent renal pain. The lesions produced include diffuse parenchymatous nephritis, hydro-nephrosis and hydro-ureter with or without infection. Haselhorst (1931) finds that out of 59 cases of pyelitis of pregnancy 39 or 60 per cent. had symptoms afterwards. Three had raised blood pressure, 4 had oedema and 19 had tenderness over the kidney region. Kidney function tests showed that there was a parenchymatous involvement. The muscle wall of the ureter is fibrosed as the result of the inflammation, so that the urinary tract returns slowly to normal. Hofbauer (1928) finds persistence of infection in 50 per cent. of cases and persistence of dilatation in 44 per cent. Corbus and Danforth (1927) in 13 cases found stricture and conclude

that pyelitis of pregnancy is due to stricture formation. Hunner (1925) also agrees that stricture is an important predisposing factor and states that if the stricture is dilated the patient may be enabled to go to full time in a subsequent pregnancy. Few workers agree with Hunner as to the frequency of ureteral stricture.

In 134 cases there were subsequent pregnancies. 87 had one subsequent pregnancy, 46 of whom had pyelitis of pregnancy again; 32 had two subsequent pregnancies, 14 of whom had pyelitis with each pregnancy, a few had pyelitis with the first and third pregnancies and not with the second; and 15 had more than 3 pregnancies. A study of the chart no.42 in the case sheet volume, shows how pyelitis recurred in pregnancy after pregnancy. Only a brief summary of the conclusions reached will be given here.

After a very severe attack of pyelitis of pregnancy the urinary tract may return to normal and the urine become sterile in an amazingly short time. As has been stated already, this is most likely to occur where the patient miscarries or has the pregnancy terminated at the height of the acute attack, and in a subsequent pregnancy this type of patient does not have a recurrence of pyelitis.

Mrs. D., case sheet no.43, is a striking example. Abdominal hysterotomy was performed because of severe pyelitis in the sixth month of pregnancy. The temperature chart shows how quickly the patient improved after operation. Fig.118 is a pyelogram taken 14 days postpartum and it shows both urinary tracts returned to normal. The urine was sterile. A second pregnancy had an uneventful course.

In cases where the urine is still infected three months postpartum with the patient under treatment, a urological examination should be performed to detect any abnormality of the urinary tract, and appropriate measures taken to remedy such abnormality if possible. It is of the utmost importance that the urine should be sterile before the next pregnancy, as where it remains infected, pregnancy causes an exacerbation. In 2 cases where the urine had become sterile between the pregnancies a fresh attack developed in the subsequent pregnancy. In both, the attack in the second pregnancy was preceded by stasis, detected by monthly chromocystoscopy. On the other hand, in several cases known to have infection of the upper urinary tract persisting from a previous pregnancy, an exacerbation during the second pregnancy did not occur. Urological examination showed that stasis did not occur in those patients. The incidence of clinical pyelitis in a subsequent pregnancy depends, there-

fore, primarily on whether stasis recurs or not with the pregnancy and secondarily on the presence of infection in the urinary tract. Where the pyelitis in the second pregnancy is simply an exacerbation of the previous infection due to the return of stasis, the patient is seldom so ill, so that in cases where the pregnancy may have required to be terminated prematurely on the first occasion, the second pregnancy may go to full time. In subsequent pregnancies the attacks of pyelitis may gradually become less and less severe and the urine finally become sterile, or the symptoms may persist between the pregnancies and become worse with each pregnancy. As will be seen from chart no.42, some of those patients in whom the symptoms became worse with subsequent pregnancy, eventually had hysterotomy with sterilisation performed, because of deteriorating health, renal calculus, ureteral stricture or haematuria. Several had accidental haemorrhage and one uraemia. As in the cases where no subsequent pregnancy occurred the incidence of permanent damage to kidney substance and to the urinary tract is high, especially where the infection persists. The following 4 cases are illustrative of the effect of pyelitis in subsequent pregnancies.

Mrs. C., case sheet no.44, under treatment for 6 weeks with a severe pyelo-nephritis during her first pregnancy. The pregnancy was terminated and the child was stillborn. During the second pregnancy a year and a half later, pyelitis recurred, with high temperature and rapid pulse rate. The infecting coliform organism gave the same sugar reactions as on the previous occasion and was probably identical. With treatment the acute symptoms disappeared and the pregnancy went to full time; the child, weighing $6\frac{1}{2}$ lbs., was born alive. During the third pregnancy an exacerbation again occurred but without fever. The organism was the same as in the previous pregnancy. The pregnancy went to full time and the child was $7\frac{1}{4}$ lbs., born alive. One year later a pyelogram of the right urinary tract, Fig.119, showed moderate dilatation of the calyces, kidney pelvis and ureter. The urine was infected but there was no stasis, as the indigo carmine appeared in 5 minutes.

The kidney substance on the right side is extensively involved and the patient's general health is still poor, although there are no urinary symptoms. A prolonged course of ketogenic diet failed to sterilise the urine. In this case the urine was infected between the pregnancies as well as during them but the stasis which was present during the pregnancies disappeared between them. The stasis was responsible for the recurrence of acute symptoms with each pregnancy, but the decrease in severity of each attack points to an increase in immunity to the infection.

Mrs. B., case sheet no.45, had an attack of pyelitis with the first pregnancy and miscarried at the seventh month. In the second pregnancy she took ill with

severe right-sided pain in the 5th. month and was admitted in labour in the 8th. month; the child was born alive but died shortly afterwards. In the third pregnancy she became ill in the 5th. month and was admitted to hospital in the 6th. month. Despite the fact that the infection was confined to the right side, she was very toxic. She had been cystoscoped at monthly intervals during the third pregnancy and in the 3rd. month there was no delay in excretion and very little dilatation of the right urinary tract. The right kidney urine contained an occasional coliform bacillus and no pus cells. A week before the acute attack, chromocystoscopy showed delay at the right side. Fig. 120 is a pyelogram taken in the 7th. month $1\frac{1}{2}$ hours after injection of uroselectan and it shows a very faint shadow and enormous dilatation of the calyces and kidney pelvis on the right side, while the left side is normal. This patient was treated by ureteral drainage on two occasions and large quantities of pus were evacuated. Improvement thereafter was striking and labour was induced at the 36th. week and a live child delivered, which survived.

In this case the patient remains almost free of symptoms between the pregnancies and looks well. The urine contains only a very occasional organism. The stasis produced by pregnancy, however, causes acute exacerbation. The dilatation affects the calyces and kidney pelvis which are probably very atonic and dilate easily in response to the slightest obstruction to outflow. Nephrectomy was advised after the second pregnancy as it is almost certain that with the left kidney alone, which is healthy, she would have gone through pregnancy without any trouble.

Mrs. G. became ill suddenly with a severe bilateral pyelitis in the 6th. month of the first pregnancy and

miscarried within a week. 1 month later the urine was sterile and no abnormality of the urinary tract could be detected by pyelography. 2 years later in the 6th. month of her second pregnancy she again had an attack of pyelitis with intense renal colic, which initiated uterine contractions and miscarriage occurred. 3 weeks postpartum the urine was again sterile and no abnormality could be detected, but 7 months postpartum she was still having attacks of right-sided renal pain.

This case is an example of an acute attack of pyelitis occurring in a urinary tract of good tone and causing miscarriage by the reflex effect on the uterus. The infection cleared up on each occasion because of the short duration of the pregnancy after the infection had developed.

Mrs. S. had a bilateral pyelitis for the first time with her sixth pregnancy. It recurred with the seventh, eighth, ninth, tenth, eleventh and twelfth pregnancies. Between each pregnancy she had intermittent attacks of pain in each iliac fossa and after the eleventh pregnancy had nephrectomy performed on the right side for stricture of the ureter. The kidney was found to be the seat of a subacute pyelo-nephritis. The twelfth pregnancy was terminated by hysterotomy and she was sterilised. Fig. 121 is a pyelogram taken in the 4th. month of the eleventh pregnancy and it shows narrowing of both ureters at the level of the pelvic brim, which was found to persist in the puerperium.

This case shows that stricture formation can occur at the level of the pelvic brim in those cases of chronic infection of long standing in multiparae. It also emphasises the fact that the kidney substance is usually extensively involved.

References to the tendency for pyelitis to recur in subsequent pregnancy are frequent in the literature.

Kretschmer (1923) observed recurrence in 2 out of 7 patients, Naujoks (1924) reports recurrence in 10 out of 28 women and Klasten (1924) in 2 out of 5. Dodds (1932) found mild recurrence in 22 per cent. in a series of 19 cases. Crabtree and Prather (1933), on the basis of a very large series of cases collected over 14 years, come to conclusions very similar to my own. They state that by far the greatest number of cured patients have uninfected subsequent pregnancy and that the few sporadic cases which are the exceptions to this rule do not alter this general principle. They stress the necessity for special treatment or even operation to ensure complete cure before a subsequent pregnancy. They give no explanation of the presence or absence of symptoms with infection, which I have shown to be dependent on the presence or absence of stasis.

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CHAPTER V.INFECTION OF THE URINARY TRACT IN THE PUERPERIUM.I. The Frequency of Urinary Infection as a cause of
Puerperal Pyrexia.

II. The Incidence of Urinary Infection in the Puerperium.

III. Pyelitis of the Puerperium.

Definition.

(a) Coli Septicaemia.

Etiology.

Clinical Features.

(b) Pyelitis of the Puerperium, and
(c) Exacerbation of Urinary Infection
persisting from pregnancy.

Incidence.

Clinical Features.

Diagnosis.

Etiology.

Treatment.

Bibliography.

Infection of the urinary tract in the puerperium is exceedingly common. It may be due to persistence of a urinary infection of pregnancy or to a primary infection arising in the puerperium for the first time. The infection of either type may be febrile or afebrile and may be unaccompanied by urinary symptoms so that, in investigating the cause of puerperal pyrexia, urinary infection must always be borne in mind.

I. THE FREQUENCY OF URINARY INFECTION
AS A CAUSE OF PUERPERAL PYREXIA.

To decide this question, a complete analysis of every case of puerperal pyrexia occurring in the hospital during one year was made. The analysis is as follows:-

Total deliveries including abortion		3600	
Notifiable pyrexia (on morning and evening chart)	252		7.0%
" " (on four-hourly chart)	<u>191</u>		<u>5.3%</u>
	Total	443	12.3%
Slight pyrexia	- - - - -	447	13.2%
Quite afebrile	- - - - -	2681	74.5%

The pyrexia rate appears high, but this is partly due to the large number of abnormal cases admitted and partly to the careful recording of four-hourly temperatures, which detected significant disturbances in many cases which would have been missed on a morning and evening chart.

In arriving at the cause of the rise in temperature, the clinical features and the response to treatment are considered together with the bacteriological findings. Anaerobic cultures have not been made and the presence of anaerobic organisms has been deduced from the clinical features and the absence of growth on aerobic cultivation. Even with the aid of bacteriological examination it has been found necessary to put many of the cases into the category of Pyrexia of Unknown Origin (P.U.O.). Where there were definite signs of uterine infection, as well as signs of other sources of infection, the case has been classified as uterine infection. None of the cases where the diagnosis was doubtful was seriously ill.

TABLE I.

Causation	Spontaneous Delivery	Complicated Delivery	Abortion	Total
(a) Septicaemia	15	16	5	36
(b) Pelvic Sepsis	6	9	4	19
(c) Uterine Sepsis	59	76	4	139
(d) Pyrexia of Unknown Origin	50	44	17	111
(e) Breast	35	12	1	48
(f) Chest	14	22	0	36
(g) Urinary	21	14	3	38
(h) Others	7	7	2	16

Table I is a detailed analysis of the cases of pyrexia and shows that 31.2 per cent. of them were extra-genital in origin. Urinary infection accounted for 38 cases, 8.5 per cent. of all the pyrexia cases, or, to put this in another way, the incidence of notifiable pyrexia due to urinary infection during the year was 1 per cent. This is a conservative estimate, as in 50 per cent. of the

cases in group (b) and (c) the urine was heavily infected and in at least 20 of these cases it was obvious that the urinary infection played an important part in the production of the pyrexia. Examination of the cases in group (g), those in which the urinary infection was the cause of the pyrexia, shows that they can be divided into four categories.

(1) Continuation of pyrexia of pyelitis of pregnancy — 11 cases. (2) Exacerbation of a chronic pyelitis of pregnancy — 7 cases. (3) Condition of urine at the time of delivery unknown — 6 cases. (4) Urine sterile at the time of delivery — 14 cases.

Therefore, in more than half the cases the urinary infection was present before labour and the puerperal pyrexia was due to either an exacerbation of a chronic infection or to the continuation of the pyrexia of an acute infection.

In Table I, 36 cases are described as septicaemia, because the infecting organism was repeatedly cultured from the blood — in 18 coliform organisms, in 10 haemolytic streptococci (accompanied by coliform organisms in 4), non-haemolytic streptococci in 2, pneumococci in 1 and in 5 probably anaerobic streptococci,

as no growth was obtained on aerobic culture and the clinical picture was that of septicaemia. Although the prognosis is better in septicaemia due to coliform organisms than in that due to haemolytic streptococci, pyrexia was prolonged in 15 of the former type and there was one death. In practically all cases of coli septicaemia a coliform infection of the urine was present. Those cases are indistinguishable clinically from pyelitis of the puerperium where blood culture is negative and will be described later in the section on pyelitis of the puerperium. If blood culture had not been done as a routine in every case of pyrexia in the puerperium they would have been diagnosed as pyelitis of the puerperium or pyrexia of unknown origin.

If we add these 18 cases of coli septicaemia to the 38 cases of pyrexia of urinary origin, the percentage of puerperal pyrexia due to infection of the urinary tract is raised to 12.6 per cent. Crabtree and Prather (1930) find the incidence of pyelitis of the puerperium to be 0.4 per cent. of all deliveries, trauma being an important predisposing factor.

II. THE INCIDENCE OF URINARY INFECTION IN THE PUERPERIUM.

The incidence of urinary infection occurring for the first time in the puerperium can only be determined by the investigation of a series of cases in which the condition of the urine is known before delivery, so that the cases in which the urinary infection persists from a pyelitis of pregnancy can be excluded.

Method of investigation. All patients admitted in labour had a catheter specimen of urine examined. If infection was present the organism was cultured on blood agar and MacConkey's medium, isolated and stored. On the 8th. day postpartum a catheter specimen of urine was again examined. In cases where pyrexia developed, a catheter specimen of urine, a cervical swab and a blood culture were all taken at the onset of fever. In cases where coliform organisms were isolated from any of these sources a specimen of faeces was examined. The organisms isolated from the various sources were compared by means of sugar reactions and agglutination tests, to find out whether they were identical or not. For the agglutination tests, where the patient's serum was found to have the power of agglutinating one of the organisms, it was used. Otherwise the serum of a rabbit which had been inoculated with one of the organisms was used.

The value of taking a catheter specimen of urine in all cases admitted in labour was early demonstrated, since frequently where the urine was heavily infected, there were no symptoms, either urinary or general. An analysis of the first 670 cases shows —

pus cells and organisms in the urine in 115 cases	-	17.1%
pus cells only	" " " " 34 "	- 5.7%
organisms only	" " " " 50 "	- 7.4%.

Albuminuria was present in 418 cases or 62.4 per cent., usually only a transient phenomenon of labour. 77 or 67 per cent. of 115 cases, where pus cells and organisms were present in the urine, had no urinary symptoms. In many of the cases in this group the infection was slight but even in 33 or 50 per cent. of the 64 cases, in which the infection was heavy, there were no urinary symptoms; and in 28 or 43.7 per cent. of these heavily infected cases, there were no symptoms to suggest any septic focus. Throughout the whole series of 2,175 cases, the findings were similar, and resemble those obtained in cases of urinary infection in pregnancy, where the absence of symptoms was a striking feature also.

In the puerperium the organism is much less frequently coliform than during pregnancy, for example, in the heavy infection group coliform organisms were cultured in 57 per cent. of cases and in slight infections in 23 per cent. In this latter group, staphylococci were seen on film and obtained in culture in 69.2 per cent. of cases.

This is in marked contrast to the antenatal period where staphylococci are seldom found in the urine.

T A B L E I I .

Urine after Delivery	Spontaneous Delivery	Complicated Delivery
Heavily infected	26 - 5.1%	53 - 25%
Slight infection	55 - 10.8%	38 - 17.9%
Sterile	424 - 84.1%	121 - 57.1%
Total	505	212

(Heavy infection indicates abundant pus cells and organisms in a fresh drop of urine, slight infection either an occasional pus cell and a few organisms or numerous organisms without pus cells in the fresh drop.)

Table II is an analysis of the findings in 717 cases in which the urine, sterile before delivery, was examined on the eighth day postpartum. It shows that, following spontaneous delivery, 5.1 per cent. of cases developed gross urinary infection and, following complicated delivery,

the incidence was 25 per cent. — five times as often.

T A B L E III.

	No Pyrexia		Slight Pyrexia		Notifiable Pyrexia	
Urine after delivery	13—3.7%	15—16.8%	3—4.9%	9—20.9%	10—11%	29—36.5%
Heavily infected	44—12.4%	20—22.4%	5—8.2%	11—25.6%	7— 7.7%	7— 8.75%
Slight infection	296—83.8%	54—60.7%	53—86.9%	23—53.5%	74—81.3%	44—35.0%
Sterile	353	89	61	43	91	80
	442		104		171	

Table III shows the incidence of urinary infection in cases of pyrexia following both spontaneous and complicated delivery, as compared with the incidence in afebrile cases. After spontaneous delivery the incidence of heavy urinary infection in cases of notifiable pyrexia was 11 per cent., and after complicated delivery 36.5 per cent., whereas in afebrile cases the incidence of heavy urinary infection was

3.7 per cent. after spontaneous delivery and 16.8 per cent. after complicated delivery. Therefore the incidence of heavy urinary infection is seen to be very much higher in cases of notifiable pyrexia after both types of delivery. The occurrence of urinary infection in the puerperium appears to be influenced by complicated delivery and associated with pyrexia, but it is important to remember that this primary urinary infection may be present in an afebrile puerperium.

A review of the literature has not revealed any similar investigation where the urine was examined before and after delivery in a large series of cases. Several workers state that infection of the urine is commoner in the puerperium than during pregnancy, for example, Dodds (1931) finds infection of the urine in 16.7 per cent. of a series of 283 "normal puerperal women", compared with 11.4 per cent. in 360 pregnant women. The urine had not been examined before delivery except in very few cases.

III. PYELITIS OF THE PUERPERIUM.

Definition.

This term is commonly used to include all cases of puerperal pyrexia associated with urinary infection but these fall into three different categories:- (a) cases of coli septicaemia, where the organism has been isolated repeatedly from the blood and where its disappearance from the blood stream coincides with a fall in temperature, (b) cases of primary infection of the upper urinary tract in the puerperium, the true pyelitis of the puerperium clinically indistinguishable from (a), but where the organism is never found in the blood stream and the pyrexia depends on the urinary infection, and (c) cases of exacerbation of urinary infection persisting from pregnancy. In a series of 3,600 consecutive cases delivered in the hospital during one year the number of cases of puerperal pyrexia due to each condition was the same.

(a) Cases of Coli Septicaemia.

A review of 50 cases has been made.

Etiology. The duration of the pyrexia depends on the presence of organisms in the blood stream. When they can no longer be obtained from the blood stream the temperature

falls. Various authors have held that organisms are normally present in the blood stream within a short time of delivery. Kulka (1932), in a series of 62 normal confinements, found organisms in the blood stream within a few minutes of delivery in 50 per cent. of cases. The organisms included haemolytic streptococci, non-haemolytic streptococci, coliform organisms and Gram-negative bacilli. He also found organisms in the blood on the first day of the menstrual flow in 6 out of 36 cases. He concludes from his observations in the puerperal cases that the occurrence of puerperal sepsis depends on the power of the patient to kill off organisms, which normally gain access to the blood stream immediately after delivery. The invasion of the uterus by organisms in the puerperium is, in his opinion, of secondary importance. To test this observation, I have made blood cultures in 280 women following complicated delivery. The blood was taken off during the first 24 hours at intervals of 5 minutes, 1 hour, 4 hours or 24 hours after delivery. In each case blood was taken at two of these intervals. In 10 cases or 3.5 per cent. organisms were isolated, coliform in 7, haemolytic streptococci in 2, and non-haemolytic streptococci in 1. The most favourable

time for obtaining a positive culture was within the first hour. There was no notifiable pyrexia in any of the positive cases and no deaths. (In contrast, it is interesting to note that 7 cases where a blood culture was made during labour because of high temperature all had organisms in the blood stream and 4 died.) From my results, therefore, it is evident that, while organisms may gain access to the blood stream in sufficient numbers to give positive blood cultures, this does not occur so frequently as has been stated by Kulka. The difference between the results is all the more striking as I was dealing with complicated delivery and Kulka with spontaneous.

The following case is an example of temporary bacteraemia following labour. Five minutes after a complicated delivery the blood culture gave a growth of coliform organisms, and 1 hour later blood culture was sterile. An identical coliform organism was isolated from the vagina, blood and faeces. The urine was sterile. It seems probable that in this case the organism was derived from the bowel, and gained access to the blood stream through lacerations in the vagina.

The incidence of coli septicaemia in the series of

3,600 cases admitted to the hospital during one year is 0.5 per cent. and is twice as great after complicated delivery as after spontaneous.

The source of the organism, which is found in the blood stream in those cases of septicaemia, is probably the bowel. In 30 cases where a specimen of faeces was examined, an organism identical with the one found in the blood was isolated in 50 per cent., and it is probable that with more intensive investigation of the faeces this percentage would have been higher because of the multiplicity of organisms in the bowel. In 5 cases of septicaemia the urine was infected before delivery and in 4 of these the organism in the blood was identical with the one in the urine. It is possible that in those cases the urine was the source of the blood infection. The mode of spread from the bowel is probably from the anus over the perineum into the vagina and by way of lacerations into the blood, predisposing factors being debility and albuminuria. It is possible that the disturbance of bowel action and purgation, which occurs after delivery, may facilitate the direct passage of organisms from the bowel to the blood.

Clinical Features. The 50 cases consisted of 24 primigravidae and 26 multiparae. The delivery was complicated in 39 and in 8 of the 11 cases in which it was spontaneous, the patient suffered from albuminuria of pregnancy, so that laceration and albuminuria are predisposing factors. In 52 per cent. of the cases, pyrexia developed within the first 3 days after delivery and in 34 per cent. it began from the eighth day onwards. It is understandable that invasion of the blood stream should occur within 3 days, but the reason for the late onset in some cases is obscure. There was usually high fever, either remittent or continuous, and rigors occurred in 56 per cent. of cases. Urinary symptoms were found in 38 per cent. of cases and comprised pain in the right kidney region in 20 per cent., pain in the left kidney region in 6 per cent., bilateral pain in 2 per cent. and bladder symptoms in 10 per cent. The kidney pain is fleeting in character and may be present only for a few hours at the beginning of the attack. Abdominal distension and discomfort are frequent in the early stages. Uterine sepsis of mild type was present in 14 or 28 per cent. These symptoms are very similar to those found in cases of pyelitis

of the puerperium. In 11 cases or 22 per cent., the pyrexia lasted for only 48 hours. In the remaining 39 cases the pyrexia lasted much longer. In 14, it lasted longer than 14 days (but in 4 of these there was also some uterine sepsis) and 2 died.

The following cases illustrate some of the points under discussion. The first two illustrate transient septicaemia after spontaneous delivery in the one and complicated delivery in the other.

Mrs. D., case sheet no.46, had a sharp elevation of temperature and a positive blood culture on the day following spontaneous delivery. As is seen on the chart, the temperature settled very quickly. The urine, which had been sterile before delivery, became heavily infected, but by the eighth day postpartum had become sterile again. Cystoscopic examination on the same day showed that the upper urinary tracts were functioning normally. The organisms isolated from the urine, vagina, blood and faeces were identical.

Mrs. M., case sheet no.47. Here also the temperature rose on the day following a complicated delivery, and fell within 3 days. In this case two organisms were isolated from the vagina, one of which was also isolated from the blood. The organism in the blood could not be isolated from the faeces although the organism in the urine, which differed from that found in the blood, was identified in the faeces.

The next case illustrates most of the clinical points already described.

Mrs. T., case sheet no.48. In this case the labour was prolonged and terminated in a forceps delivery.

The abdomen was distended on the third day postpartum and there was retention of urine. In this case the renal tenderness was a more prominent feature than usual and of longer duration, probably due to the heavy infection and poor function of the upper urinary tracts, which were revealed by cystoscopic examination. The organisms isolated from the urine, blood, vagina and faeces were identical. 20 days postpartum the right urinary tract was still heavily infected although the temperature and pulse rate were normal.

The persistence of infection was probably due to the atonic condition of the ureter and renal pelvis. Where the ureters are not atonic, the infection clears up quickly.

The following 3 cases illustrate late onset of symptoms.

Mrs. M., case sheet no.49, suffered from retention of urine till the fifth day postpartum, after which urine was passed freely. On the seventh day she had a rigor and temperature of 103° and a coliform organism was isolated from the blood. The blood culture remained positive until the 16th. day postpartum. There were no urinary symptoms, although the urine which was sterile before delivery now contained abundant pus cells and coliform organisms, which were identical with the one isolated from the blood. The temperature subsided when the organisms disappeared from the blood.

Mrs. D., case sheet no.50, had premature labour at 33 weeks as the result of severe albuminuria. The puerperium was normal until the 12th. day, when she developed a slight rise of temperature and pulse rate of 120. On the 14th. day the blood culture was positive but by the 18th. day, temperature and pulse were again normal. Cystoscopic examination performed on that day showed that elimination from both sides was normal and that the urine from both kidneys was only slightly infected, although the bladder urine was still heavily infected.

Mrs. J., case sheet no.51, had a prolonged labour with forceps delivery. On the 8th. day post-partum, she had a rise of temperature to 103° with a rapid pulse rate and no symptoms. The blood culture was found to be positive and remained so for 3 days. Cystoscopic examination done on the 15th. day showed elimination to be normal from both sides and a few organisms present in the urine from both kidneys, while the bladder urine contained abundant pus cells and coliform organisms. Bladder lavage was instituted and 4 days later the urine contained only a few coliform organisms.

As has been already mentioned, the onset of the infection was delayed until the 8th. day or later in 17 cases or 34 per cent., and the above are typical examples of this. Possible explanations of the delayed onset will be discussed later in the section dealing with pyelitis of the puerperium.

The following 3 cases show the difficulty in arriving at the exact diagnosis.

Mrs. D., case sheet no.52. The urine was infected before delivery and on the 3rd. day she developed a temperature of 104° with positive blood culture and tenderness in the left kidney region. On the 5th. day temperature was still elevated and there was evidence of uterine infection. Following intra-uterine glycerine treatment, the temperature fell. Identical coliform organisms were isolated from the urine, vagina and blood, but not from the faeces. It is probable that the organism in the urine was the source of the blood stream and uterine infection. It is unlikely that a local uterine infection would give rise to a temperature of 104° with rigors, so that the probable diagnosis in this case is septicaemia.

Mrs. P., case sheet no.53. The chart shows that on the day following delivery she developed a temperature of 103° , a rigor and tenderness in the left kidney region. The temperature settled in 6 days but rose again in 48 hours and kept swinging for 14 days, until a piece of placental tissue was removed from the uterus, after which the temperature settled immediately. The presence of infection in the left kidney was confirmed by cystoscopy. In this case the early pyrexia was due to the blood infection, while the later disturbance was due to uterine infection.

Mrs. W., case sheet no.54, on the 4th. day after manual removal of the placenta, developed typical uterine sepsis with heavy urinary infection and negative blood culture. The temperature subsided on the 10th. day following glycerine treatment. On the 15th. day the temperature again rose with pain in the right kidney region, and positive blood culture. The urine was now sterile and, as is seen from the case sheet, the coliform organism isolated from the blood was different from that isolated from the faeces. A few days later, oedema of the right leg developed and fullness was made out in the right fornix. The cause of the temperature here was thrombosis of the deep pelvic veins.

It is apparent, therefore, that very careful examination is necessary in every case of puerperal pyrexia to ascertain its true nature, and even then this may be difficult. In the absence of blood culture the condition may be missed altogether. Very often infection of the urinary tract occurs following the septicaemia but the pyelitis or pyelo-nephritis so produced usually clears up quickly and in the cases cystoscoped there has been little evidence of stasis, except in some cases in the bladder.

Of 30 cases examined after two years only 2 had any infection of the urine and most of them were in good health. This is in marked contrast to the after-results in pyelitis of pregnancy and emphasises that the urinary tract is not seriously affected.

(b) Pyelitis of the Puerperium, and (c) Exacerbation of Urinary Infection persisting from pregnancy.

The incidence of pyelitis of the puerperium is quoted by most workers as about 1.5 per cent. of all cases delivered. Walther and Willoughby (1933) find "postpartum kidney" infection in 1.5 per cent. of 2,400 cases delivered. Dodds (1932) finds an incidence of postpartum pyelitis of 1.6 per cent. of 3,789 cases delivered. Neither of these workers distinguish between primary pyelitis of the puerperium and exacerbation of antenatal pyelitis. In my series of 3,600 cases delivered, the incidence of both conditions together with coli septicaemia is 1.5 per cent., which indicates that they make no distinction between the three conditions. The numbers of cases in each of the three groups were approximately equal in the series, so that the

incidence of true pyelitis of the puerperium is 0.5 per cent. of all cases delivered. Infection of the urinary tract in the puerperium is, however, very much more common and I have shown that 11 per cent. of all women who had sterile urine before delivery have a heavy infection of the urine afterwards. This incidence is influenced by the type of delivery, being 5.1 per cent. after spontaneous delivery and 25 per cent. after complicated delivery. Table IV shows the incidence of pyrexia of urinary origin in such cases.

T A B L E IV.

CAUSE OF PYREXIA	STERILE URINE		INFECTED URINE	
	Spontaneous Delivery	Complicated Delivery	Spontaneous Delivery	Complicated Delivery
Septicaemia	4	8	4	1
Beyond Uterus	3	5	1	0
Uterine	39	48	6	8
Pyelitis	6 or 9.79%	8 or 2.2%	14 or 6.5%	6 or 8.3%
Chest	9	11	3	2
Breast	19	7	6	0
Miscellaneous	6	1	1	2
Pyrexia of Unknown Origin	26	18	2	3
Totals	112 out of 752	106 out of 351	37 out of 214	22 out of 72

Table IV shows that out of 1,103 cases in which the urine was sterile before delivery, 14 or 1.2 per cent. developed pyrexia of urinary origin. The pyrexia rate is similarly influenced by the type of delivery, being 0.79 per cent. after spontaneous delivery and 2.2 per cent. after complicated delivery. Apparently, therefore, even where heavy infection of the urine occurs for the first time in the puerperium it only gives rise to pyrexia in 1 out of every 11 cases. Where pyrexia does not occur, I have classified the condition as cystitis, on the assumption that infection of the upper urinary tract would cause pyrexia. Where the urine is infected before delivery, the incidence of pyrexia in the puerperium is only slightly greater than it is in patients where the urine is sterile before delivery. The incidence of pyrexia of urinary origin, however, is much greater in this group, 20 cases out of 286 cases delivered, or 7 per cent. The incidence is also increased where the delivery is complicated. The incidence of uterine sepsis is slightly lower in this group than where the urine was sterile before delivery. The incidence of true pyelitis of the puerperium can only be assessed where the condition of the urine is known before delivery.

Clinical Features. There were 84 cases altogether of pyelitis of the puerperium and exacerbation of antenatal pyelitis. There were 41 primiparae and 43 multiparae. The clinical features are similar to those of the septicaemia cases, but the blood cultures are negative. If blood culture had been done oftener, positive results might have been obtained, but unless some correlation between the presence of the organisms in the blood and the pyrexia could be established, the diagnosis of septicaemia could not be made. Delivery was spontaneous in 49, of which 39 had albuminuria of pregnancy. The time of onset of the pyrexia appears to be related to the condition of the urine before delivery. In 20 cases the urine was known to be sterile before delivery and in 16 of those or 80 per cent. the onset of the pyrexia was late — 8th. day or later. In 27, the urine was known to be infected before delivery and the onset of the pyrexia was within 3 days of delivery in 23 or 85.1 per cent. In 37, the condition of the urine before delivery was not known, and in 13 or 35 per cent. the pyrexia occurred early and in 24 or 65 per cent. it occurred late. It is probable that in this latter group the urine was infected in some cases and sterile in others. Rigors

occurred in 23 cases or 27 per cent.; urinary symptoms in 49 or 42 per cent., only slightly more often than in the septicaemia group; right renal pain in 15 or 17 per cent.; left renal pain in 9 or 10 per cent.; bilateral pain in 10 or 11 per cent.; pain and frequency of micturition in 14 or 16 per cent. and retention of urine in 12 or 14 per cent. The pain seldom lasted longer than 12 to 24 hours. The pyrexia lasted longer in the cases where the urine was sterile before delivery. In 4 or 20 per cent. it lasted longer than 2 weeks, and in 10 or 50 per cent. it lasted less than 1 week. In the cases where the urine was infected before delivery the pyrexia lasted more than 2 weeks in 3 or 11 per cent. and less than 1 week in 20 or 74 per cent. In 12 or 44 per cent., it lasted less than 3 days.

Mrs. B., case sheet no.55, is a typical example of primary pyelitis of the puerperium. This patient suffered from albuminuria during the pregnancy and on the 9th. day postpartum, developed pain in the left renal region and a temperature of 101° . The blood culture was negative. Cystoscopic examination on the 11th. day postpartum showed that the left kidney urine was infected, while the urine from the right kidney was sterile. The urea concentration of the urine from the left kidney was 0.6 per cent., while that from the right was 2.6 per cent. This suggests marked damage to the kidney substance on the left side.

It is remarkable that such gross disturbance of kidney function should occur with a pyrexia of such short duration,

but the following case proves that it can occur.

Mrs. B., case sheet no.56, a primigravida, after a prolonged labour had craniotomy performed and from the 2nd. to the 5th. day postpartum had a temperature of 101° with abdominal distension and tenderness over both kidneys. The urine was heavily infected. The puerperium was uneventful after the 5th. day. During the 2nd. pregnancy she had pyuria, which was found to be coming from the right urinary tract but there were no urinary symptoms. She died of haemorrhage from a central placenta praevia at the 36th. week and on post-mortem examination the right kidney showed an extensive subacute pyelo-nephritis, while the left had many fibrosed areas, due to healed abscesses.

The pyelo-nephritis dated from the first puerperium, so that we see what extensive damage can occur with a pyrexia of only 3 days' duration.

Diagnosis. If pyrexia occurs within 3 days of delivery it is due to (1) a prolongation of a pyrexia of a pyelitis of pregnancy, or (2) exacerbation of a chronic pyelitis of pregnancy, in which case temporary invasion of the blood stream by the organism is the usual cause, or (3) the presence of organisms in the blood stream, derived from the bowel. In this third group the urine is sterile before delivery but becomes infected. These are cases of septicaemia but they usually result in pyuria. If pyrexia occurs later, from the 8th. to the 10th. day, it may be due

to (1) exacerbation of a chronic pyelitis of pregnancy, but this is unusual, or (2) more commonly, invasion of the blood stream by organisms derived from the bowel, or (3) primary infection of the urinary tract, probably by the ascending route from the bladder. In both (2) and (3) the urine is sterile before delivery.

Etiology. In the 84 cases of the series, a pure growth of coliform organisms was less frequently found than in pyelitis of pregnancy, coliform organisms alone in 53 cases or 64 per cent., coliform and other organisms in 14 cases, streptococci in 6 and staphylococci in 5.

The early onset in some cases is easily explained, either by the condition being due to a prolongation of a pyrexia of a pyelitis of pregnancy, or to an exacerbation of a chronic pyelitis of pregnancy or to invasion of the blood stream by organisms from the bowel probably through lacerations. The late onset in those cases where the pyrexia does not occur until the 8th. or 9th. day postpartum is more difficult to explain. In cases of coli septicaemia it may be due to separation of sloughs aggravated by the more active movements of the patients which occur at this

stage of the puerperium, thus allowing organisms to pass from the genital tract into the blood stream. The following considerations may provide a possible explanation of the late onset in the cases where the blood culture was negative, that is, in the cases I have termed true pyelitis of the puerperium.

It has long been believed that retention of urine is an important predisposing factor in the production of those infections. Randall and Murray (1933) found retention of urine in 21 per cent. of a large series of cases after delivery. They define retention as inability to empty the bladder within 8 to 12 hours postpartum and they advocate repeated catheterisation until no residual urine is found in the bladder. By this procedure they claim to have avoided all postpartum urinary complications in 3,500 cases. In a series of 100 cases, I found residual urine on the 8th. day in 17 per cent. In 5 of the 17 the residual urine amounted to more than 4 ozs. The high incidence of residual urine may explain, to a certain extent, the greater liability to urinary infection in the puerperium. Rose and Rollins (1931) state that the postpartum atony of the bladder occurs mostly in primigravidae and is due to pressure of the child's head on the pudendal nerve during a prolonged second stage.

In other cases the condition is a reflex mechanism from dilatation and trauma of the pelvic outlet. They advocate repeated catheterisation as long as there is residual urine. This prevents pyelo-nephritis. The postpartum atony of the bladder, in my experience, is too common to be explained altogether in this way. Even where the bladder is grossly infected in the puerperium, there is seldom any pyrexia and often no symptoms of any kind. Cystoscopic examination in such cases shows that the bladder, especially the trigone, is acutely inflamed and oedematous yet, contrary to the usual finding in cystitis in the non-pregnant, the bladder capacity is not diminished but may be increased to as much as 40 or 50 ozs., which probably accounts for the lack of bladder symptoms. Chromocystoscopy shows that the kidneys and ureters are functioning fairly normally, so that one did not feel justified in passing a ureteral catheter from such an infected bladder to confirm the presence or absence of infection in the upper urinary tracts, and, as already stated, the afebrile cases were classified as cystitis. Such an infected bladder, however, is a potential source of danger to the upper urinary tracts by ascending infection. The post-mortem finding in a fatal case shows evidence of an

ascending infection. The bladder and ureters were extensively involved. Fig.122 is a section of a part of the right kidney pelvis which was also involved. It shows engorgement of the vessels of the wall of the ureter, oedema and leucocytic infiltration. The epithelium has also been destroyed. Fig.123 is a section of the medulla of the left kidney, showing involvement of the collecting tubules extending in a characteristically streaked arrangement towards the cortex. Fig.124 is a section of the same area under higher magnification and it shows some of the tubules cut longitudinally and filled with pus. There is also very extensive destruction of tubules. Fig.125 is a section from the renal cortex of the same kidney and it shows that the streaked area of infection has extended upwards, causing destruction of the convoluted tubules.

According to the experimental work of Cunningham and Graves (1924), reflux from the bladder into the ureters does not occur unless the bladder tone is good. The ureter resists the back-flow by contracting more frequently, until finally its resistance is overcome. If the bladder is atonic, the increased intravesical pressure due to distension does not produce reflux. To test for reflux in

the puerperium, I examined 7 primiparae on the 8th. day postpartum and 1 primipara on the 4th. day postpartum. The bladder was filled with 6 per cent. sodium iodide until the patient complained of discomfort. X-Ray photographs were then taken to see if a shadow of the ureter or kidney pelvis could be obtained. Pressure over the bladder with the patient in the Trendelenburg position was then applied for 10 minutes and another X-Ray photograph taken. In 7 out of the 8 cases the bladder held over 40 ozs. without any discomfort being produced and reflux was not observed in any of the 7 cases. In the eighth case acute pain was complained of after 20 ozs. had been injected and in this case a shadow of the right ureter was obtained, showing reflux to have occurred. Subsequently on cystoscopic examination the right ureter was found to be more atonic than the left, so that reflux occurred more easily on the right side. Although these figures are too small to enable one to draw independent conclusions, they agree with the results of Cunningham and Graves.

The interval which must elapse before the urine in the bladder becomes grossly infected and before the infection ascends to the kidney probably accounts for the late

onset of pyrexia in those cases of primary pyelitis of the puerperium.

A point worthy of note in the cases which were X-rayed is that although there was no residual urine, which meant that the bladder was emptying efficiently, yet it could be distended with 50 ozs. of sodium iodide without causing pain or any discomfort. This indicates a lack of sensitivity of the bladder in the puerperium and accounts for the lack of symptoms in cases of cystitis.

The experimental work suggests that atony of the ureters would predispose to ascending infection by offering less resistance to reflux and, as described in Chapter III, atony of the ureters is a marked feature of the puerperium. The inability to pass urine in the early stages of the puerperium causes distension of a bladder which may still be sufficiently active to cause reflux into a ureter whose tone is diminishing, and so, if the bladder urine is infected, an ascending infection of the urinary tract is begun. Fig.126, a microphotograph of a section of the left ureter at the level of the pelvic brim from a patient who died on the 4th. day postpartum, shows acute inflammation of the mucosa and submucosa. The inflammation involved the

bladder and ureter up to the level of the pelvic brim. The kidney pelvis and upper half of the ureter were not affected. This finding supports the theory of ascending infection.

Treatment.

Treatment on general lines with abundant fluid and alkalies is efficient in the acute stage of all three types of case, but to render the urine free from infection requires different measures in each type. The cystoscopic findings in the puerperium are entirely different from those in pregnancy. During pregnancy there is delay in emptying of the upper urinary tract with efficient emptying of the bladder, while in the puerperium, the delay in emptying of the upper urinary tract quickly disappears but retention of urine in the bladder is frequent. (Residual urine was found in 17 per cent. of cases on the 8th. day postpartum.) During pregnancy, therefore, one finds gross infection of the upper urinary tract with little or no infection of the bladder, while in the puerperium the position is reversed. In cases with marked pyrexia the kidney urine is found to contain a few pus cells and organisms, while the bladder contains abundant pus cells and organisms with several ounces

of residual urine. Difficulty is experienced in obtaining good visualisation of the bladder and the ureteral orifices are difficult to see, because of the widespread injection and oedema of the base of the bladder, a condition which practically never occurs during pregnancy. This corresponds to the clinical features, namely, the prominence of renal symptoms in the acute stages of pyelitis of pregnancy and the absence or the transient nature of renal symptoms in pyelitis of the puerperium. The absence of bladder symptoms in pyelitis of the puerperium is explained by the lack of sensitivity of the bladder in the puerperium to which reference has already been made.

In the cases of septicaemia, although the pyrexia lasted for more than a fortnight in 28 per cent. of cases, the patients did not look ill and the evening rise of temperature was practically the only symptom. After the temperature settled the urine was found to be still heavily infected but on cystoscopic examination the infection was found to be almost entirely confined to the bladder. In some cases several ounces of residual urine were found and daily catheterisation until this had disappeared, was found to be very beneficial in clearing up the infection. Although

many of the patients on dismissal from hospital still had pus cells and organisms in the urine, a "follow up" showed that 2 years later out of 30 cases only 2 had any urinary infection — in both cases, bacilluria. Eleven patients had had a subsequent pregnancy without any infection of the urine, so that the after-results of coli septicaemia are very satisfactory.

If primary pyelitis of the puerperium is to be regarded as an ascending infection from the bladder, then treatment should be directed to the bladder in the first place. According to Randall and Murray, pyelitis of the puerperium will be prevented by catheterising the bladder in all cases where the patient cannot pass urine 12 hours after delivery and repeating it daily until there is no residual urine. In their opinion the infection of the bladder and the resulting ascending infection are due to stasis of urine in the bladder. In this country the opposite view is usually taken that catheterisation should only be used as a last resort, because of the risk of introducing infection by the catheter. The prophylaxis of early catheterisation of the bladder in the puerperium is certainly worth a trial, as by our present methods gross infection of the bladder arises

in 11 per cent. of all cases delivered. Randall and Murray claim to have eliminated pyrexia due to urinary infection in a series of 3,500 puerperal cases by early catheterisation of the bladder. Walther and Willoughby advocate ureteral drainage in pyelitis of the puerperium, either by repeated lavage or by indwelling catheter, on the ground that the temperature was reduced to normal in from 1 to 18 days in 13 cases so treated, but very few cases of pyelitis of the puerperium have pyrexia for any longer when treated by medical means. It is difficult to see the need for ureteral drainage, as in my series there was very little stasis in the ureters.

Where the pyrexia is due to an exacerbation of a pyelitis of pregnancy, the pyrexia usually lasts only for a few days on medical treatment, but the urine in a large proportion of cases remains infected for months or years in spite of strenuous local treatment, such as repeated renal lavage.

Colebrook and Fuller (1933) have published the results of the treatment of 54 cases of puerperal infection of the urinary tract by ketogenic diet. They show that in 24 or 44 per cent. the urine became sterile within 17 days of

the commencement of the diet. In 44 per cent. they failed to produce a satisfactory ketosis and believe this to be the cause of their failure to render the urine sterile. They make no distinction between primary infection of the urine in the puerperium and exacerbation of an antenatal pyelitis. Some of the failures may have been of this latter type, since the upper urinary tract is more involved.

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CHAPTER VI.

PREGNANCY COMPLICATED BY OTHER PATHOLOGICAL CONDITIONS
OF THE URINARY TRACT.

I. Pregnancy with a Single Kidney.

II. Congenital Abnormalities of the Urinary Tract.

III. Hydronephrosis.

IV. Urinary Calculus.

V. Haematuria in Pregnancy.

Bibliography.

It is evident from the previous chapters that a urological department is necessary in any large maternity hospital for the diagnosis and treatment of urinary infection during pregnancy and the puerperium. Careful urological examination is also essential to detect many of the less common abnormalities of the urinary tract which may complicate pregnancy. The following is a short survey of a few of those conditions which I have encountered. If routine X-Ray examination, including pyelography, had been done in every case, the number of those abnormalities would have been greater, as frequently the symptoms resemble those of urinary infection, with which they may co-exist, or no urinary symptoms may be present. It is therefore impossible to give an accurate idea of the incidence of those conditions.

I. PREGNANCY WITH A SINGLE KIDNEY.

I have observed the course of pregnancy in five women who had only one kidney. In 4, nephrectomy had been performed at least a year before the beginning of pregnancy, and in one where nephrectomy was performed during the pregnancy the kidney had been functionless for a long time. In all these cases, therefore, there had been adequate time

for the remaining kidney to undergo compensatory hypertrophy. In one, the right kidney had been removed and no dilatation of the left urinary tract occurred during the pregnancy. In the other four, the left kidney had been removed and in three, very little dilatation or stasis occurred. In the fourth, marked dilatation of the calyces and kidney pelvis occurred. Fig.127 is an intravenous pyelogram in this case at 20 minutes in the seventh month of pregnancy and it shows that although the dilatation is marked, the shadow is dense indicating good kidney function. The urea concentration test gave a reading of 2.1 per cent. in the third hour. In all five cases pregnancy was uneventful. This is not surprising as it has been calculated that one-sixth of the total kidney substance is all that is necessary to maintain satisfactory excretion. Pérez, Sosa and Sanchez (1930) collected 246 cases where nephrectomy had been performed for various conditions and in which 270 pregnancies occurred with 20 complications and 3 deaths. They conclude that the risks of pregnancy with a single kidney are not very great but they advocate an interval of 2 to 4 years after nephrectomy before pregnancy is undertaken.

II. CONGENITAL ABNORMALITIES OF THE URINARY TRACT.

Pyelography has shown that congenital abnormalities of the urinary tract are much more common than was formerly supposed, as these are frequently symptomless. In a series of 94 healthy pregnant women I have encountered complete reduplication of one or other urinary tract in 3 cases and reduplication of both urinary tracts in 1. In 3 there were no symptoms but in 1 there was pain at the level of the pelvic brim where the two ureters crossed one another. In one of the cases the double kidney was rotated so that the hilum pointed outwards and Fig.128 is a pyelogram taken at the fourth month of pregnancy in this case showing that the right urinary tract is normal, while on the left side the calyces of both kidneys are pointing inwards towards the vertebral column. The ureters do not show, as there is no stasis. This patient had no renal symptoms.

There were 2 cases of congenital cystic kidney. One, a primigravida, was well during the course of pregnancy and had a normal labour, the child weighing $7\frac{1}{2}$ lbs. She was given an anaesthetic for the insertion of several perineal stitches and died under the anaesthetic. Post-

mortem examination revealed congenital cystic kidneys.

Fig.129 is a photograph of one of the kidneys, showing how extensive was the disease. The other was the case of a IV-para, who was admitted in the fourth month of pregnancy because of threatened abortion. There had been 3 normal full-time pregnancies. A catheter pyelogram, Fig.130, shows the enormous elongation of the kidney pelvis on both sides, with only moderate dilatation, indicating great enlargement of the kidney, appearances characteristic of congenital cystic disease of the kidneys. Abdominal palpation confirmed the diagnosis. Miscarriage occurred and the patient was dismissed well from hospital.

There was one case of horseshoe kidney, in a II-para, admitted in the fourth month of pregnancy because of profuse haematuria. There were no other symptoms. The first pregnancy had been uneventful. The urine contained abundant coliform organisms, pus and blood. Cystoscopic examination showed that there was no delay in excretion from the left side and that the urine from that kidney was sterile and free from blood. There was marked delay at the right side and abundant blood, pus and organisms in the urine. Fig.131 is a catheter pyelogram of the right side,

showing an enormous hydronephrosis in a horseshoe kidney. In another plate the calyces in the left side were found to point inwards, indicating that the kidney stretches over the vertebral column. The ureter is undilated and crosses in front of a very dependent calyx. Fig.132 shows that this calyx contains a calculus which may have been the cause of the haemorrhage. The haemorrhage cleared up and the pregnancy went to full time. This case shows that gross abnormality of the urinary tract, with a calculus, can be present without causing pain.

III. HYDRONEPHROSIS.

It has been stated by some authors that pyelitis of pregnancy develops in women who have some abnormality of the urinary tract. I have shown that this is not the case and the following four cases illustrate that the clinical picture of cases with gross abnormality of the urinary tract is quite different from that of pyelitis of pregnancy.

Mrs. McM., a primigravida, had suffered for seven years from attacks of right-sided renal pain, worse before the menstrual period. During pregnancy the attacks had been more severe and more frequent, and at the end of the eighth

month she was admitted to hospital because of the onset of pyrexia. On admission the urine was found to contain a few pus cells and coliform organisms. The temperature was 99° and the pulse rate 110 and there was severe pain over the right kidney region, so severe that as the child was viable the pregnancy was terminated. Fig.133 is a pyelogram taken 8 days postpartum and it shows the enormous dilatation of the calyces and kidney pelvis on the right side with only slight dilatation of the ureter. The left side is normal. The condition was probably due to narrowing at the ureteropelvic junction. The changes produced are not those characteristic of pregnancy.

Mrs. B., a primigravida, suffered from attacks of pain in the left kidney region for many years. During the pregnancy, attacks were more frequent and lasted for about 3 days at a time. Fig.134 is an intravenous pyelogram taken one hour after injection of uroselectan in the fifth month and shows an enormous external hydronephrosis on the left side. Although the calyces showed in 20 minutes after injection, the kidney pelvis gave a shadow for the first time at the end of 1 hour. The patient was able to continue to full time although she had attacks of renal colic at

intervals.

Mrs. T., a IV-para, in the fourth month of pregnancy had a cystoscopic examination which showed marked delay in emptying of both urinary tracts, no indigo carmine being seen at either orifice in 25 minutes. An intravenous pyelogram taken 1 hour after injection of uroselectan, Fig. 135, shows an enormous external hydronephrosis on the left side with an undilated ureter. The ureter was seen for the first time at 1 hour after injection. On the right side the kidney pelvis is seen to be dilated to a much less extent. During the seventh month she was again cystoscoped and indigo carmine appeared at the right ureteric orifice 7 minutes after injection and at the left side in 10 minutes. The pyelogram in Fig. 136, taken 20 minutes after uroselectan, shows that the hydronephrosis on the left side is much smaller and that the ureter shows at this stage. Although the left kidney pelvis can be seen folded on itself, it is emptying more efficiently than at the fourth month. This patient had no urinary symptoms.

Mrs. R., a III-para, case sheet no. 58, had had two previous premature labours at the seventh month. In the sixth month of the third pregnancy a cystoscopic examination

showed marked stasis on both sides. The urea concentration test showed that both kidneys, especially the left, were not functioning satisfactorily. The intravenous pyelogram, Fig.40, shows gross dilatation of the calyces and kidney pelvis on both sides. The patient again had a premature labour at the seventh month and urea concentration tests on the sixth day postpartum showed that kidney function had improved considerably and chromocystoscopy showed that the stasis was much less. It is likely that bilateral hydro-nephrosis produced during each pregnancy is responsible for the deterioration of kidney function and the premature labour. The cause in this case is probably a congenital weakness in the musculature of the upper urinary tract.

IV. URINARY CALCULUS.

I have found in the course of urological examination in pregnant women 8 cases of urinary calculus.

Mrs. B., a VII-para, was admitted in the sixth month of pregnancy with right renal pain and a temperature of 100°. The temperature settled in 5 days and the pregnancy went to full time. One year later she still complained of pain and radiological examination showed a stone in the right

kidney pelvis. This was later passed spontaneously and the symptoms cleared up.

Mrs. H., a IV-para, since the birth of the second child had suffered from attacks of left-sided pain and was admitted in the fourth pregnancy with haematuria. The condition was diagnosed as albuminuria of pregnancy. Five months postpartum, pain in the left side was still severe and cystoscopic examination showed marked delay in emptying both urinary tracts. Fig.137, the plate taken preliminary to pyelography, shows an enormous branching calculus filling the kidney pelvis and calyces on the right side and a smaller calculus on the left side. This patient became pregnant again and abdominal hysterotomy with sterilisation was carried out. This case shows the value of a preliminary X-Ray plate, as in a pyelogram the condition would have been indistinguishable from a hydronephrosis. The absence of pain in the right renal tract is remarkable.

Mrs. P., a II-para, had a normal full-time pregnancy and was first seen in the third month of the second pregnancy, complaining of pain in the left side of 14 days' duration. No previous symptoms of any kind. The urine contained numerous pus cells and coliform organisms and cystoscopic

examination showed normal elimination from the right side and marked delay at the left. A catheter was obstructed at 13 cms. in the left ureter. X-Ray examination showed a large calculus at the pelvic brim in the left ureter. An intravenous pyelogram in Fig.138, done at the same time, failed to give a shadow on the left side in 2 hours. The right urinary tract is slightly dilated. At operation a huge pyonephrosis was found, the wall of the sac containing no functioning kidney tissue. The patient made a good recovery and the pregnancy went to full time. In this case also, there was a striking absence of symptoms.

Mrs. C., a primigravida, had had appendicectomy performed 4 years previously for right-sided pain which, however, persisted. She was seen in the fifth month of pregnancy, complaining of severe pain in the right iliac fossa. Urological examination showed that the right ureter was obstructed at 3 cms. from the bladder. The urine was heavily infected with pus and coliform organisms. A preliminary X-Ray plate, Fig.139, showed 2 calculi in the lower part of the right ureter and an intravenous pyelogram, Fig.140, taken immediately afterwards shows an enormous dilatation of the calyces, kidney pelvis and ureter on the

right side. Meatotomy was performed and the stones were passed. The pain subsequently disappeared.

Mrs. M., II-para, had had appendicectomy for right-sided pain 13 years previously, with no relief. Two years later, calculi were removed from the right kidney. The first pregnancy was uneventful. During the second pregnancy and for 3 years previous to it she had severe attacks of right-sided pain. A catheter pyelogram, Fig.141, performed in the fifth month, shows the left tract to be normal and the right ureter obstructed just below the kidney. Two calculi are seen in the kidney region. The urine was heavily infected. The pregnancy went to full time. Some time later, nephrectomy was performed and the pain disappeared and the urine became sterile.

Mrs. McK., a primigravida, had had appendicectomy 3 years previously for right-sided pain, with no relief. One year later laparotomy was performed for 'adhesions', but the pain was still unrelieved. During the early months of pregnancy she had several attacks of severe pain and at the fifth month developed a typical attack of pyelitis which settled after ureteral catheterisation. Premature labour occurred at the eighth month as the result of the severe renal

colic. An X-Ray photograph taken during the pregnancy, showed a calculus in the right kidney pelvis. Six weeks postpartum, a pyelogram, Fig. 142, shows that the calculus is now situated at the level of the pelvic brim. The severe pain which had been in the kidney region during the pregnancy was now complained of in the right iliac fossa. The stone was removed by operation and a subsequent pregnancy went to full time, without any discomfort.

Mrs. D., case sheet no. 24, has already been described in detail. She died of peritonitis following perforation of the ureter by a calculus. She had been suffering from right-sided pain for several years.

Mrs. B. has already been described under the heading of congenital abnormalities, as she had a horseshoe kidney.

Those cases show that careful urological examination is necessary to come to an exact diagnosis, as they all had infection of the urine and 3 had pyrexia and were indistinguishable clinically from cases of pyelitis of pregnancy. Three had had an appendicectomy performed without benefit; 2 had haematuria and in one it was the only symptom. The

removal of the stone caused the immediate disappearance of the symptoms. In the fatal case, if urological examination had been done sooner, the death could have been avoided.

V. HAEMATURIA IN PREGNANCY.

Although haematuria is only a symptom, it occurs so frequently during pregnancy from little-understood causes that it has come to be regarded as a clinical entity. In the series of 1,000 antenatal cases already referred to in Chapter IV, there were 53 cases of haematuria, consisting of -

	<u>severe</u>	<u>slight</u>
albuminuric toxæmia, including		
chronic nephritis - - - - -	9	7
pyelitis - - - - -	6	6
miscellaneous - - - - -		23
hydronephrosis - - - - -	1	
acute toxic vomiting in		
later months - - - - -	1	

In the cases of albuminuric toxæmia the bleeding is usually bilateral and occurs in the severe pre-eclamptic type or in the cases of chronic nephritis with high blood pressure. In the pyelitis cases it is almost always unilateral and may occur at the beginning of an acute attack or

without any warning in a chronic case. In the case of Mrs. O., haematuria occurred for the first time during an acute attack of left-sided pyelitis of pregnancy. It recurred at intervals following the pregnancy and during the course of the second pregnancy. Fig.143 is an intravenous pyelogram taken in the eighth month of the second pregnancy and it shows that the most dependent calyx of the left kidney is not functioning, as it is probably the seat of a severe pyelonephritis and the source of the haemorrhage. In such cases haemorrhage may come from the congested vessels of the renal papillae, or of the wall of the ureter. Fig.144 is a microphotograph of a section of one of the renal papillae in a case of chronic pyelonephritis and it shows the distended thin-walled vessels in the renal papilla. Fig.145 is a microphotograph of a transverse section through the wall of the ureter in a similar case. The distended blood vessels are plainly seen projecting into the lumen. In some cases bleeding may be dependent upon stretching of the kidney pelvis or calyces, and the relief of tension by inserting a ureteral catheter may stop the bleeding very quickly. Difficulty is usually encountered in preventing obstruction

of the catheter by blood clot. Middleton (1929) offers the same explanation of the beneficial effect of catheters in cases of haematuria by the relief of tension. Stoeckel (1931) says that it is surprising that haematuria does not occur more frequently in cases of chronic pyelonephritis.

Nephrectomy may be required eventually if the patient becomes too anaemic but, although the haemorrhage is often profuse, it seldom lasts for more than a few days at a time, so that nephrectomy is not required as an emergency measure.

(The operations of nephrectomy and meatotomy in the cases described in this chapter were performed by Mr. Jacobs, Urologist, Glasgow Royal Infirmary.)

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no.8, 485.

*(not consulted in the original).

THE URINARY TRACT IN PREGNANCY

AND THE PUERPERIUM

WITH SPECIAL REFERENCE TO

PYELITIS OF PREGNANCY

by

DUGALD BAIRD.

APPENDIX A.

Fig.1. A catheter pyelogram in a case of pelvic cellulitis.

Fig.2. A retrograde pyelogram of the left urinary tract in a case of malignant ovarian cyst.

Fig.3. An intravenous pyelogram in a case of simple ovarian cyst, pressing on the left ureter and causing deformity similar to that produced by pregnancy.



Fig. 1.



Fig. 2.



Fig. 3.

Fig.4. An intravenous pyelogram, at 45 minutes,
in a case of a very large ovarian cyst,
compressing the right ureter.

Fig.5. An intravenous pyelogram in the same
case at 60 minutes.

Fig.6. A retrograde pyelogram in the same case
10 days after operation. Right
urinary tract now normal.



Fig. 4.



Fig. 5.



Fig. 6.

Fig.7. An intravenous pyelogram in a case of a large ovarian cyst pressing equally on both sides of the pelvic brim.

Fig.8. A retrograde pyelogram in a case of ovarian cyst which reached to the umbilicus and pressed equally on the pelvic brim on both sides.



Fig. 7.



Fig. 8.

Fig.9. A retrograde pyelogram in a case of small ovarian cyst, which caused painful spasm of the left ureter, at the narrow area indicated in the photograph.

Fig.10. An intravenous pyelogram in a case of left-sided cervical fibromyoma. The shadow, although faint, shows that the left ureter is dilated throughout its whole length.



Fig. 9.



Fig. 10.

Fig.11. A photograph of the urinary tracts of a multipara, who died on the 9th. day postpartum.

Fig.12. A diagrammatic representation of the distribution of the changes found in pregnancy.



Fig. 11.

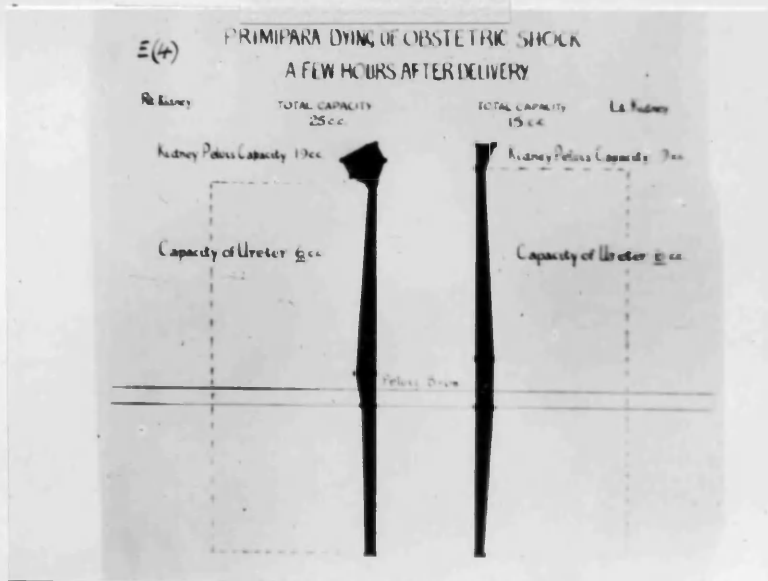


Fig. 12.

Fig.13. A photograph of the urinary tracts of a woman who died in the puerperium. The dilatation affects the kidney pelves and calyces mostly, but the typical distribution of dilatation is seen in the ureters.

Fig.14. A photograph of the urinary tracts of a woman who died in the puerperium. The left urinary tract is little affected.

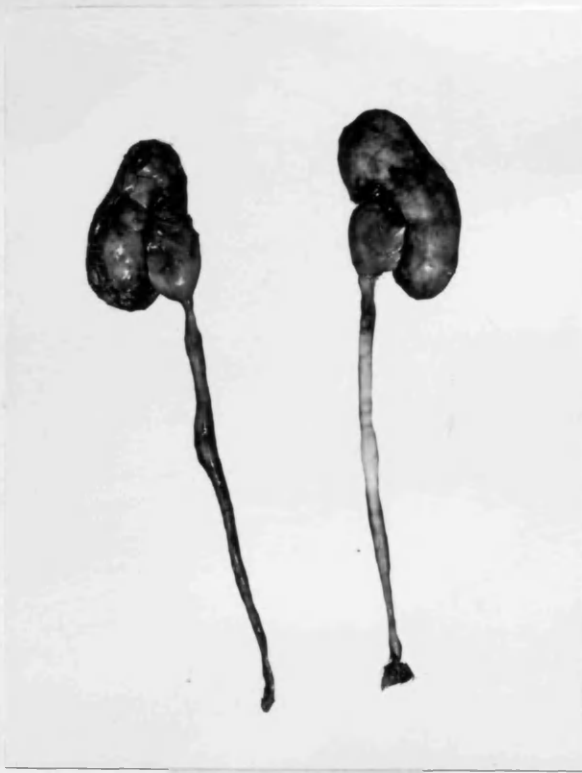


Fig. 13.



Fig. 14.

Fig.15. A photograph of the urinary tracts of a primipara who died one month postpartum.

Fig.16. A photograph of the urinary tracts of a primipara who died of pyelitis one week postpartum. The right ureter is dilated below the pelvic brim, as is frequently the case in pyelitis of pregnancy of long-standing.



Fig. 15.



Fig. 16.

Fig.17. A photograph of the urinary tracts of a primipara who died a few hours after delivery. The deformity on the left side resembles that on the right.

Fig.18. A photograph of the urinary tracts of a woman who died in the puerperium. Both ureters are dilated from the pelvic brim upwards.

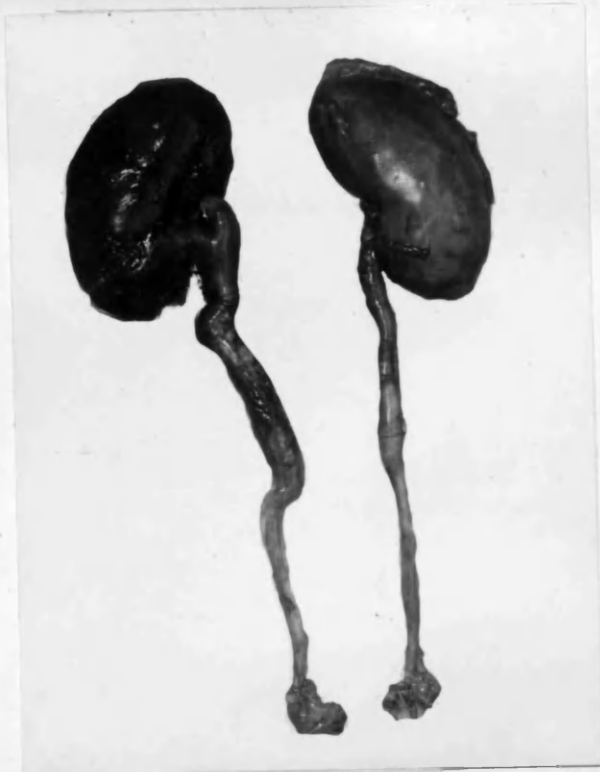


Fig. 17.



Fig. 18.

Fig.19. A photograph of the urinary tracts of a woman who died in the puerperium, showing gross dilatation of the right urinary tract with very slight dilatation of the left.

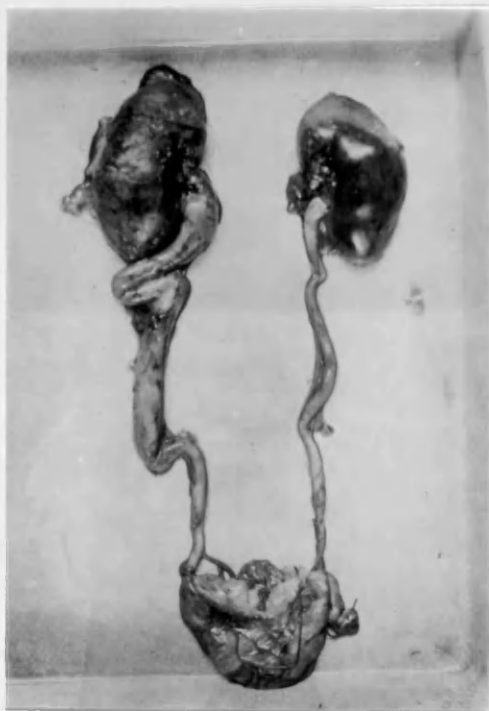


Fig. 19.

Fig.20. A photograph of the kidneys of a primigravida, opened to show the flattening of the renal papillae of the right kidney, due to dilatation of the pelvis and calyces.

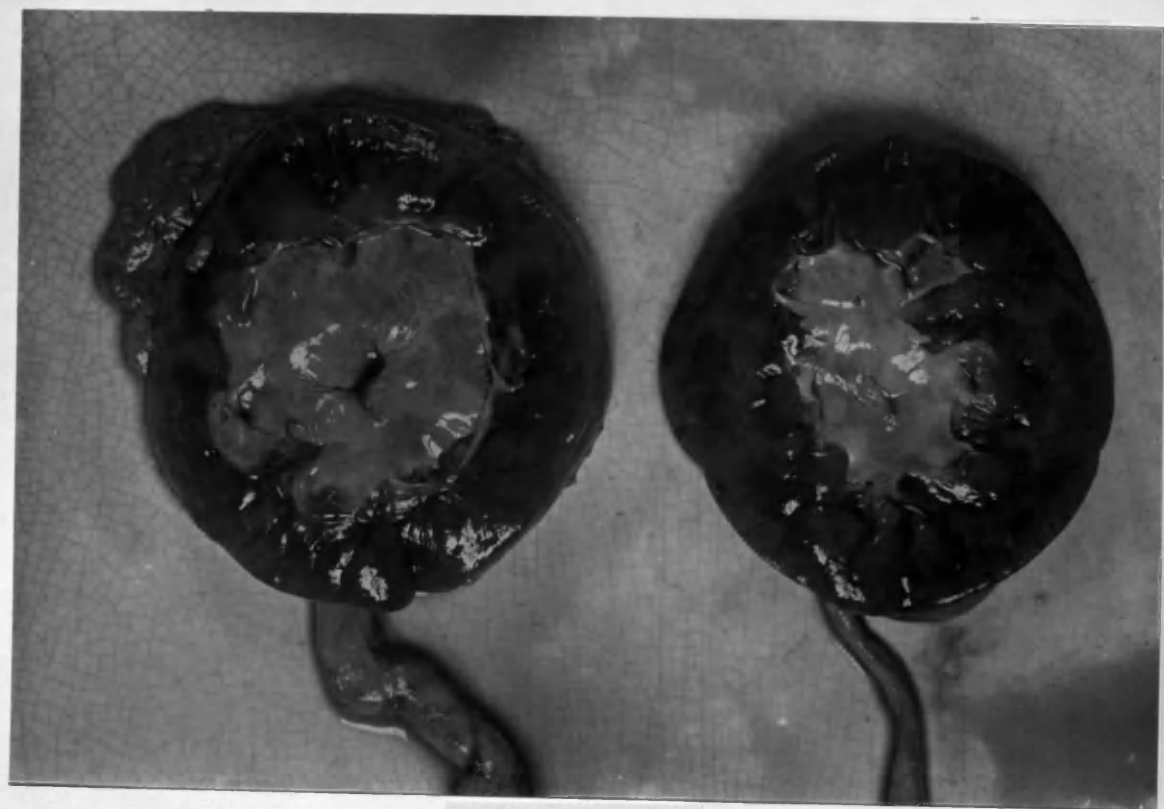


Fig. 20.

Fig.21. A photograph of a right ureter split longitudinally to show narrowing of the lumen at the apex of the kinks.



Fig. 21.

Fig.22. A photograph of the urinary tracts of a primipara who died 48 hours after delivery, showing acute kinking of the right ureter.



Fig. 22.

Fig.23. A microphotograph of a sagittal section of the most acute kink seen in the right ureter in Fig.22. It shows definite narrowing of the lumen.



Fig. 23.

Fig.24. A microphotograph of a transverse section of the ureter where it enters the bladder, in a nullipara aged 18 years. The scanty ureteral sheath is indicated by the arrow, U.S.
(B.M. bladder musculature).

Fig.25. A microphotograph of a similar section of the ureter in a nullipara of 38 years, showing how thin the sheath is, indicated by the arrow, U.S.
(B.M. bladder musculature).

U.S.

B.M.



Fig. 24.

U.S.

B.M.

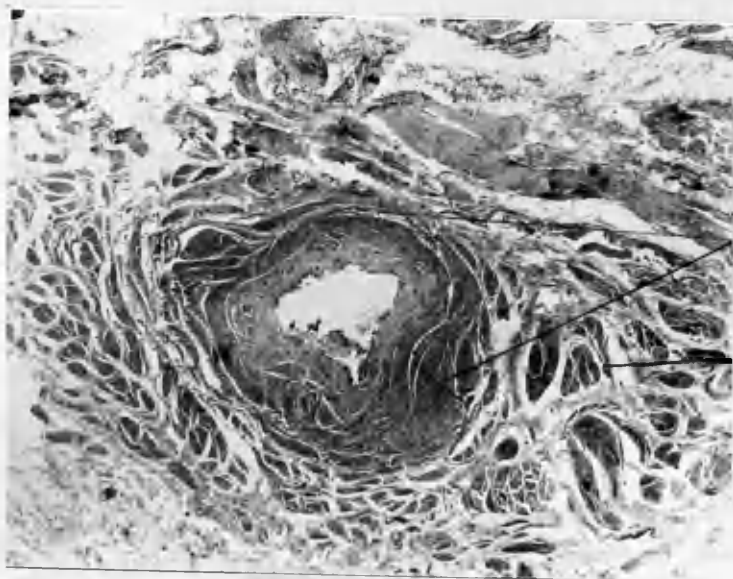
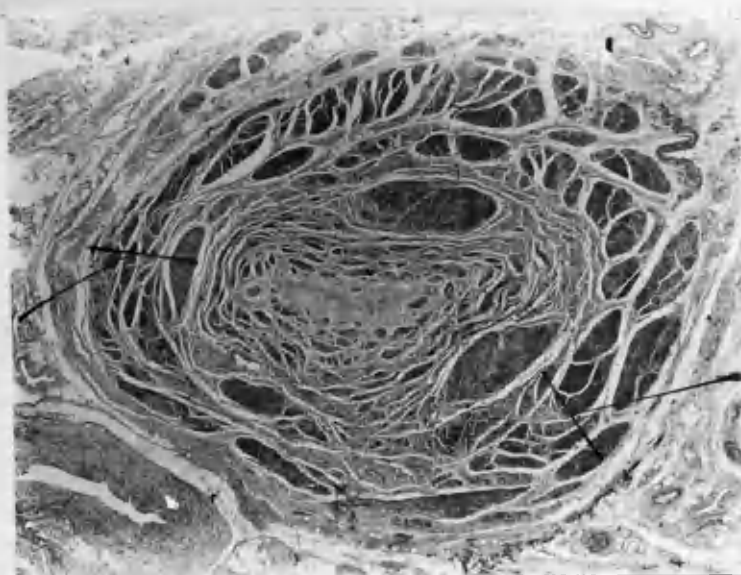


Fig. 25.

Fig.26. A microphotograph of a section of the right ureter where it enters the bladder in a primipara who died on the 4th. day postpartum. The ureteral sheath (U.S.) is uniformly distributed round the ureter and hypertrophied.

Fig.27. A microphotograph of a section of the same ureter just below the crossing of the uterine artery. The same hypertrophy is evident.

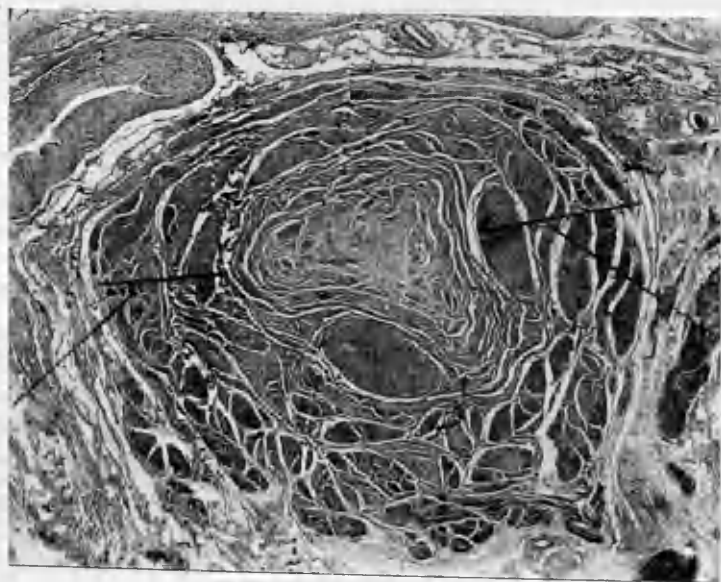
U.S.



U.S.

Fig. 26.

U.S.



U.S.

Fig. 27.

Fig.28. A microphotograph of a transverse section of the right ureter of a pregnant woman in the pelvic portion.

Fig.29. A microphotograph of a transverse section of the same ureter above the pelvic brim. The wall is thinned out and the muscle fibres stretched.



Fig. 28.



Fig. 29.

Fig.30. A microphotograph of the right ureter
above the pelvic brim of a woman
near full time.

Fig.31. A microphotograph of a section of the
left ureter at the same level in
this case.

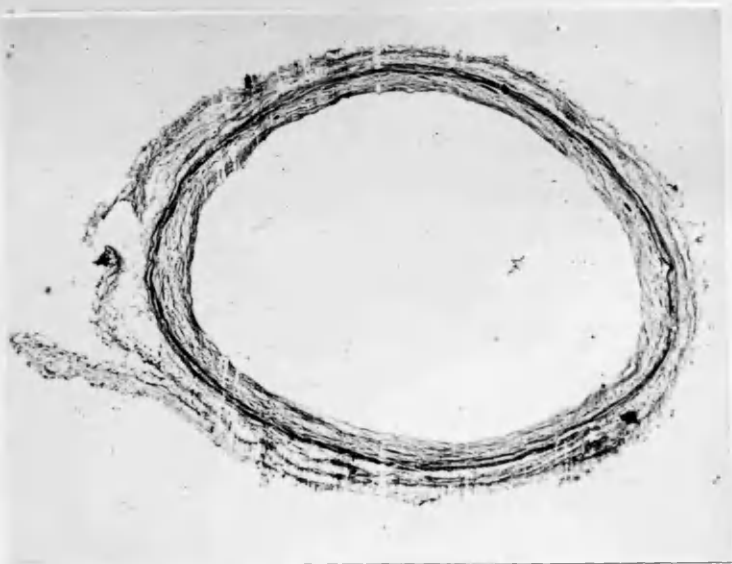


Fig. 30.

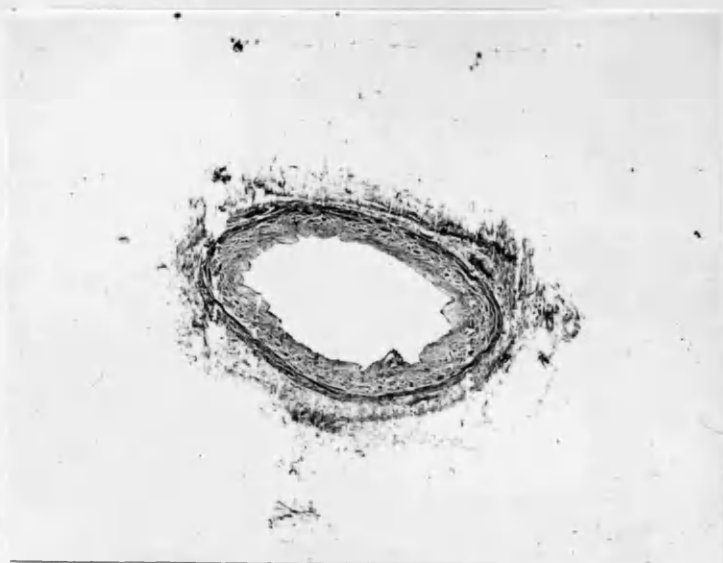


Fig. 31.

Fig.32. A microphotograph of a small portion of the wall of the right ureter, seen in Fig.30. It shows stretching of both the longitudinal and circular muscle fibres, as compared with Fig.33, which is a similar section from the left ureter in the same case.

X 100

Fig.33. A microphotograph of a similar section of the left ureter seen in Fig.31.
S.M. submucosa.
L.M. longitudinal muscle fibres.
C.M. circular muscle fibres.
Ad. adventitia.
(In practically all of the sections of the ureter shown, the mucosa is absent as it is shed very soon after death, especially in pregnancy.)

X 100.



Fig. 32.

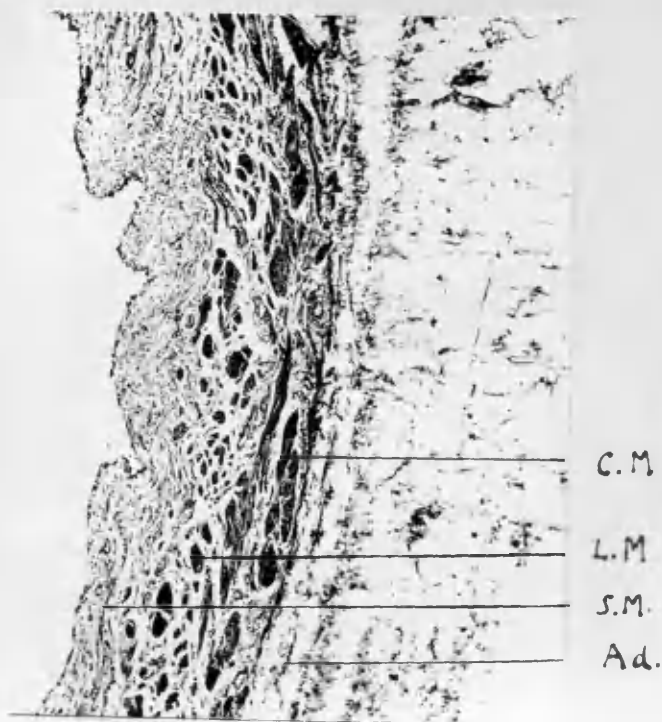


Fig. 33.

Fig.34. A sketch of the urinary tracts in situ
of a primipara who died within a few
hours of delivery by Caesarean Section.

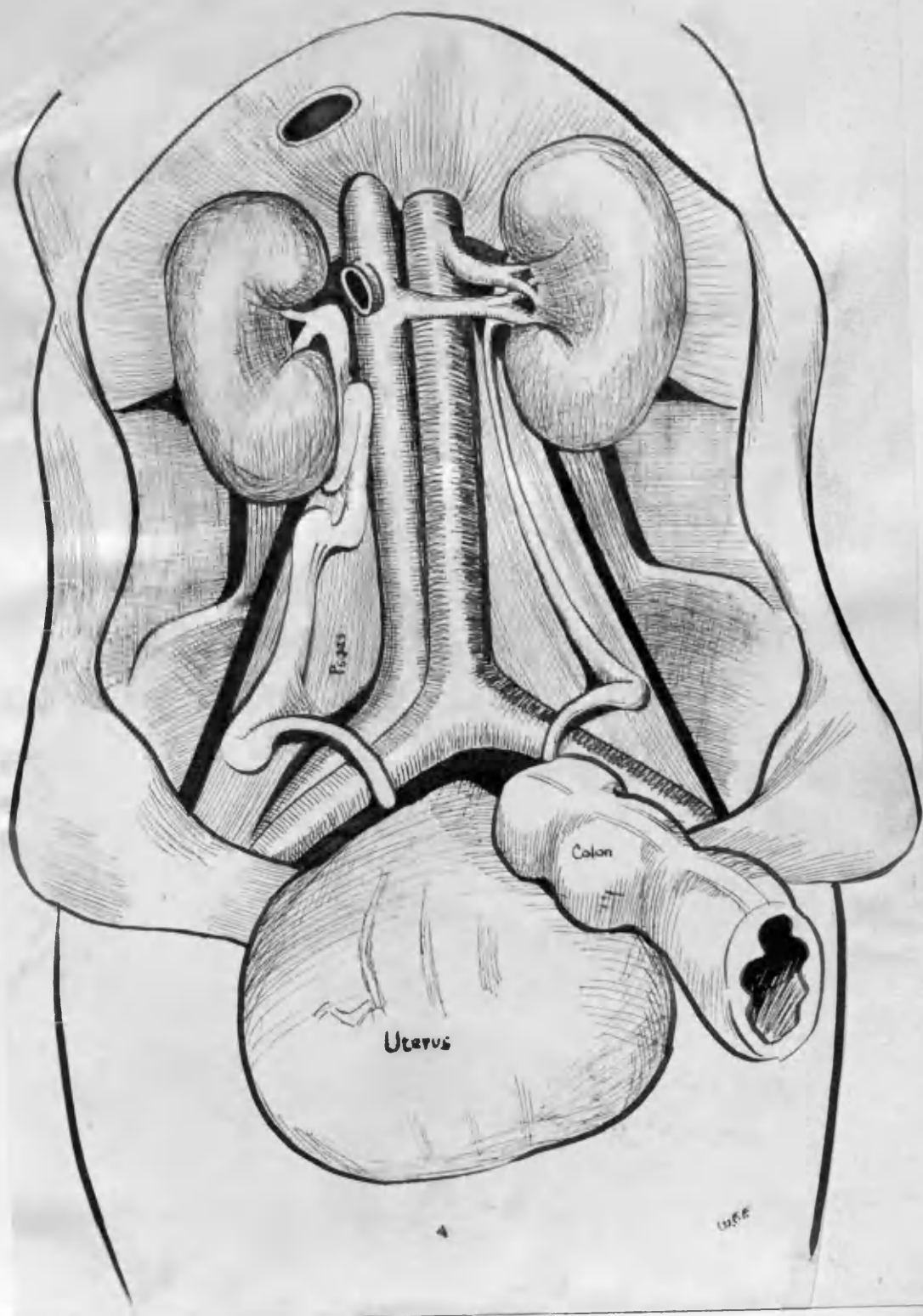


Fig. 34.

Fig. 35. An intravenous pyelogram in a case of scolierachitic pelvis, with enormous dilatation of the right urinary tract.



Fig. 35.

Fig.36. Diagrammatic representation of the use
of ureteral catheterisation after
injection of indigo carmine in
determining the site of obstruction
to outflow.

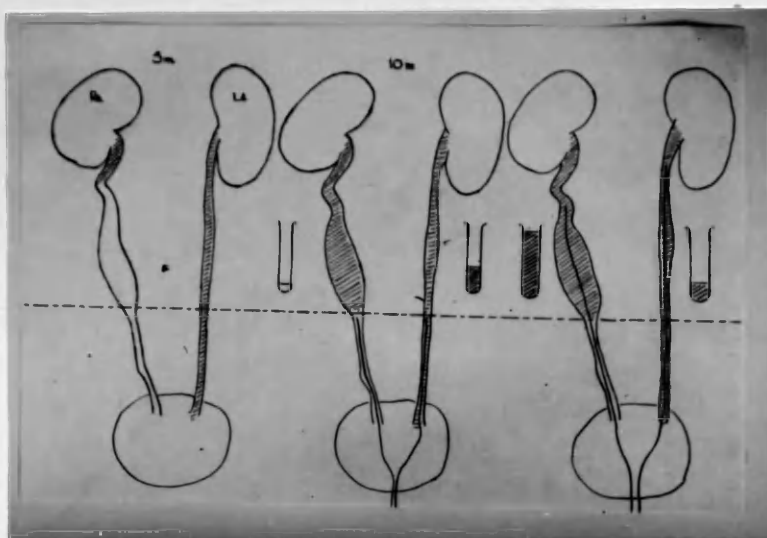


Fig. 36.

Fig.37. An intravenous pyelogram at 7 minutes
in a primigravida in the 7th. month
of pregnancy.

Fig.38. An intravenous pyelogram at 20 minutes
in the same case.

Fig.39. An intravenous pyelogram at 40 minutes
in the same case. Right ureter now
showing for the first time.



Fig. 37.



Fig. 38.



Fig. 39.

Fig.40. An intravenous pyelogram in a multipara
in the 7th. month of pregnancy.
(Case no.58).

Fig.41. An intravenous pyelogram in the same
case on the 10th. day postpartum.
Shadow very unsatisfactory.

Fig.42. A retrograde pyelogram in the 6th. week
postpartum shows that there is still
very considerable dilatation, with
narrowing of the ureteropelvic junction
on both sides.



Fig. 40.



Fig. 41.



Fig. 42.

Fig.43. Intravenous pyelogram at the 3rd. month of pregnancy in case no.1. Ureters dilated and kinked.

Fig.44. An intravenous pyelogram at the 4th. month in the same case. Less dilatation.

Fig.45. An intravenous pyelogram at the 5th. month in the same case. Dilatation and kinking of both urinary tracts, more than at 3rd. month.



Fig. 43.



Fig. 44.



Fig. 45.

Fig.46. An intravenous pyelogram at the 8th. month in case no.1. Dilatation has remained stationary at the left side but has increased at the right.

Fig.47. An intravenous pyelogram at the 5th. month in case no.2. Kinking and dilatation of both tracts, especially of the right.

Fig.48. An intravenous pyelogram in the same case at the 9th. month. Left renal tract undilated and straight. Right ureter does not show.



Fig. 46.



Fig. 47.



Fig. 48.

Fig.49. An intravenous pyelogram at the 4th. month
in case no.3. Slight kinking of ureters.

Fig.50. An intravenous pyelogram at the 5th. month
in case no.3. Dilatation and kinking
of both urinary tracts, especially the
right.

Fig.51. An intravenous pyelogram at the 8th. month
in the same case. Left urinary tract
now undilated and straight. Right
kidney pelvis and calyces more dilated,
the outer border of psoas muscle plainly
seen, flattening inner border of kidney
pelvis.



Fig. 49.



Poser
Mysia

Fig. 50.



Fig. 51.

Fig.52. An intravenous pyelogram at 4 minutes in case no.4 at the 6th. month. Slight kinking of ureters. Tracts undilated.

Fig.53. An intravenous pyelogram at 20 minutes in the same case at the 6th. month. Both tracts uniformly dilated.



Fig. 52.



Fig. 53.

Fig.54. An intravenous pyelogram in case no.4
at the end of the 7th. month.

Fig.55. An intravenous pyelogram in case no.4
at the 9th. month. Left urinary
tract now practically undilated,
ureter lying along outer border of
psoas muscle. Marked dilatation of
right calyces and kidney pelvis.
Only a small part of right ureter
showing as it is flattened against
the psoas muscle.



Fig. 54.



Fig. 55.

Fig.56. An intravenous pyelogram at the 5th. month in case no.5. Slight kinking and dilatation of both ureters down to the pelvic brim.

Fig.57. An intravenous pyelogram at 5 minutes at the 7th. month in a multipara. Both urinary tracts showing, the left normal and the right very dilated, therefore no delay in excretion.



Fig. 56.



Fig. 57.

Fig.58. An intravenous pyelogram, at 7 minutes,
in case no.6, at the end of the
4th. month. Delay in excretion at
right side.

Fig.59. An intravenous pyelogram, at 30 minutes,
in the same case, at the end of the
4th. month. Right ureter now showing.



Fig. 58.



Fig. 59.

Fig.60. An intravenous pyelogram, at 7 minutes,
in case no. 4, at the 6th. month.
Calyces only showing on the right side.

Fig.61. An intravenous pyelogram, at 30 minutes,
in the same case at the 6th. month.
Kidney pelvis now seen, more dilated.
Ureter not yet showing.

Fig.62. An intravenous pyelogram, at 40 minutes,
in the same case, at the 6th. month.
Ureter now showing no more dilated but
displaced laterally.



Fig. 60.



Fig. 61.



Fig. 62.

Fig.63. An intravenous pyelogram at 7 minutes
in case no.7, at the end of 4th. month.
Normal left tract. Only a faint
shadow of calyces on right side.



Fig. 63.

Fig.64. An intravenous pyelogram at 20 minutes in case no.7, at the end of the 4th. month. Right kidney pelvis and calyces now showing clearly, moderately dilated.



Fig. 64.

Fig.65. An intravenous pyelogram at full time in case no.8. Site of obstruction in the ureter is at the pelvic brim.

Fig.66. A retrograde pyelogram at the 10th. day postpartum in the same case. Ureters no longer displaced laterally. A filling defect at the pelvic brim is still seen in the right ureter.



Fig. 65.



Fig. 66.

Fig.67. An intravenous pyelogram in the 6th. month in a multipara. Enormous dilatation of right tract.

Fig.68. A retrograde pyelogram in the 6th. month in the same case. Point of obstruction is at pelvic brim.

Fig.69. A retrograde pyelogram at 3½ months postpartum in the same case. Dilatation still persists.



Fig. 67.



Fig. 68.



Fig. 69.

Fig.70. An intravenous pyelogram at 7 minutes in case no.9, in the 10th. week of pregnancy. Dilatation of right kidney pelvis and calyces with kinking at the ureteropelvic junction.



Fig. 70.

Fig.71. An intravenous pyelogram at 7 minutes
in case no.9, in the 6th. month.
Right urinary tract scarcely perceptible.

Fig.72. An intravenous pyelogram at 20 minutes
in the same case, in the 6th. month.
No shadow of right ureter yet.

Fig.73. An intravenous pyelogram at 75 minutes
in the same case, in the 6th. month.
Right ureter now showing, only
slightly dilated and displaced
medially.



Fig. 71.



Fig. 72.



Fig. 73.

Fig.74. An intravenous pyelogram in the same case near full time. Left urinary tract now dilated and displaced laterally.

Fig.75. An intravenous pyelogram in a primigravida at the 6th. month. Marked bilateral dilatation of the kidney pelvis and calyces. Acute bilateral pyelitis developed in this case.



Fig. 74.



Fig. 75.

Fig.76. An intravenous pyelogram in a primigravida at the 7th. month. Extreme elongation and kinking of the right ureter.

Fig.77. An intravenous pyelogram in a primigravida in the 6th. month. Dilatation of both tracts and kink at the right uretero-pelvic junction.



Fig. 76.



Fig. 77.

Fig.78. A tracing in a primigravida in the 3rd. month of pregnancy. In all tracings both horizontal and vertical scales are in cms., 1 cm. on the horizontal line representing 2 minutes, and 1 cm. on the vertical line representing 2 ccs. of urine expelled.

CUNNINGHAM

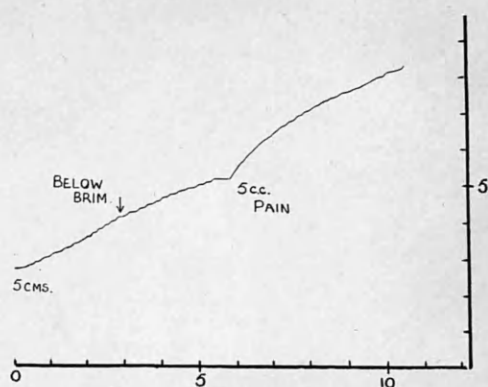


Fig. 78.

Fig.79. A tracing in case no.6 at the 18th. week of pregnancy. Compare pyelogram in Fig.59 taken in this case at the same stage of pregnancy. Proof of obstruction to outflow caused by the pressure of the pregnant uterus at the pelvic brim.

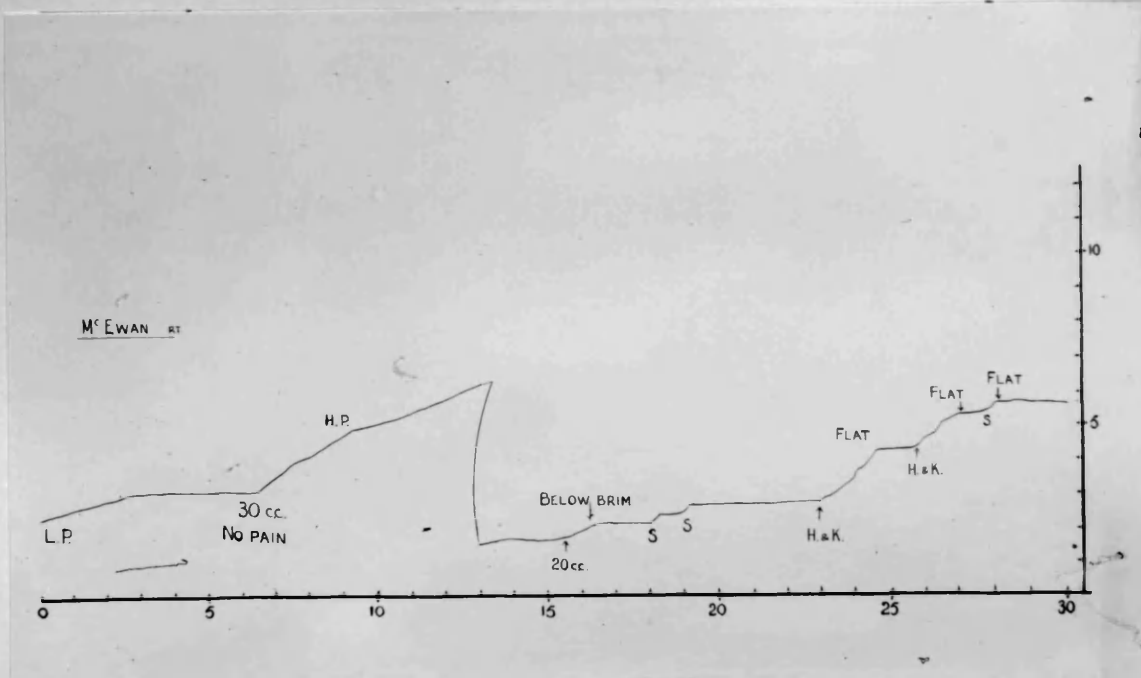


Fig. 79.

Fig.80. Tracings in 2 cases, A and B, in which the ureteral tone was approximately equal. In A no stasis occurred at the pelvic brim, but in B marked stasis was present. Abdominal wall was very lax in A, so that pressure on the ureter was probably less.

B

A

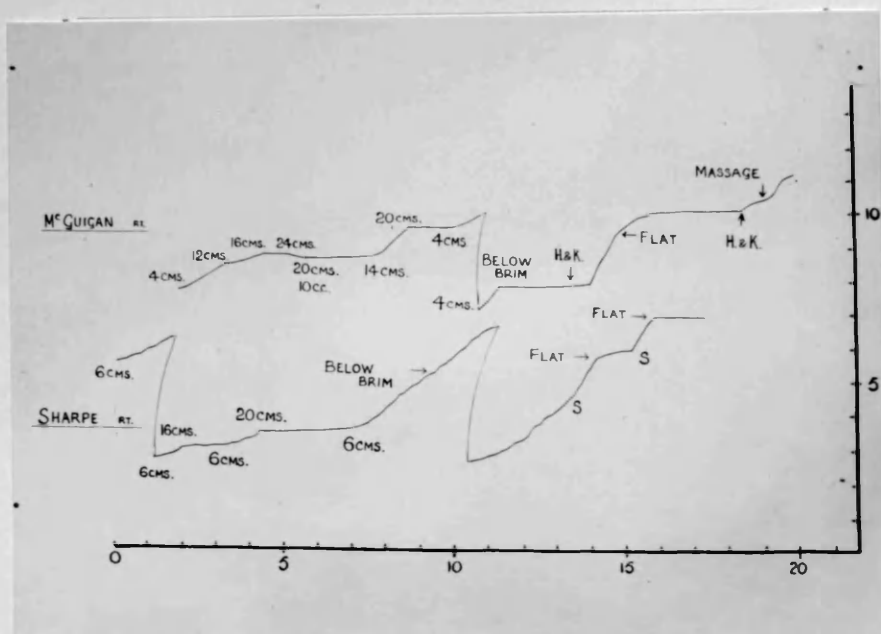


Fig. 80.

Fig.81. An intravenous pyelogram in case A
(tracing shown in Fig.80). Very
slight dilatation of right ureter.



Fig. 81.

Fig.82. An intravenous pyelogram in the 8th. month in a primigravida. Marked dilatation and kinking of right urinary tract above the pelvic brim.

Fig.83. A tracing made in the same case at the same time, with a catheter in the right ureter, shows that the uterus obstructs the ureter at the pelvic brim, and that the obstruction can be relieved somewhat by change of posture.



Fig. 82.

M'MENEMY, RT.

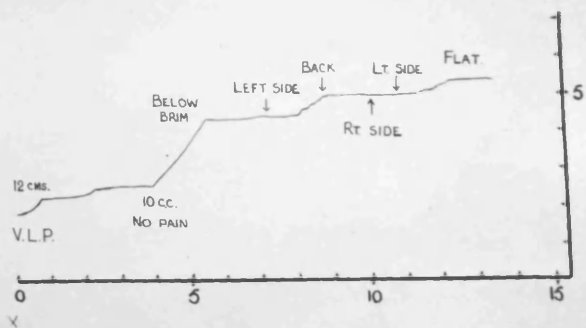


Fig. 83

Fig.84. A retrograde pyelogram in a multipara at the 7th. month, showing obstruction of the ureter by the uterus flattening it against the psoas muscle.

Fig.85. A tracing made in the same case at the same time, with a catheter in the right ureter, showing that the tone of the abdominal muscles affects the pressure on the ureter.



Fig. 84.

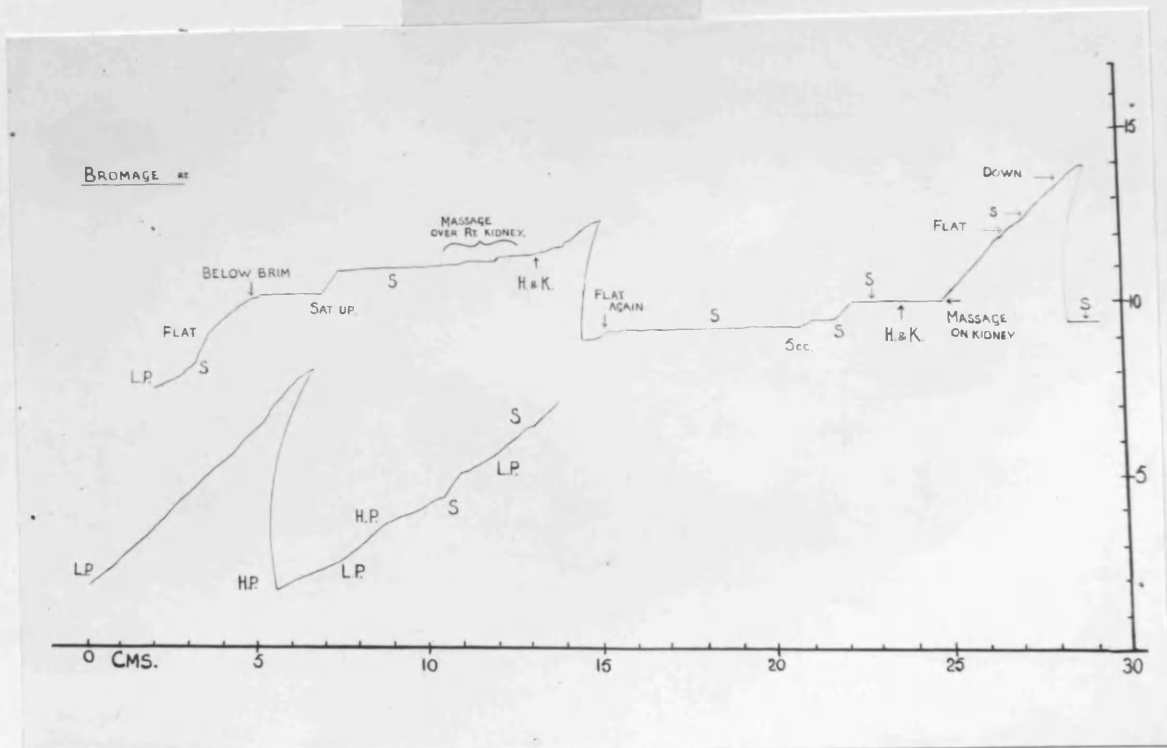


Fig. 85.

Fig.86. Tracings made in case no.10, before and after delivery. It shows that the obstruction at the pelvic brim is removed after delivery.

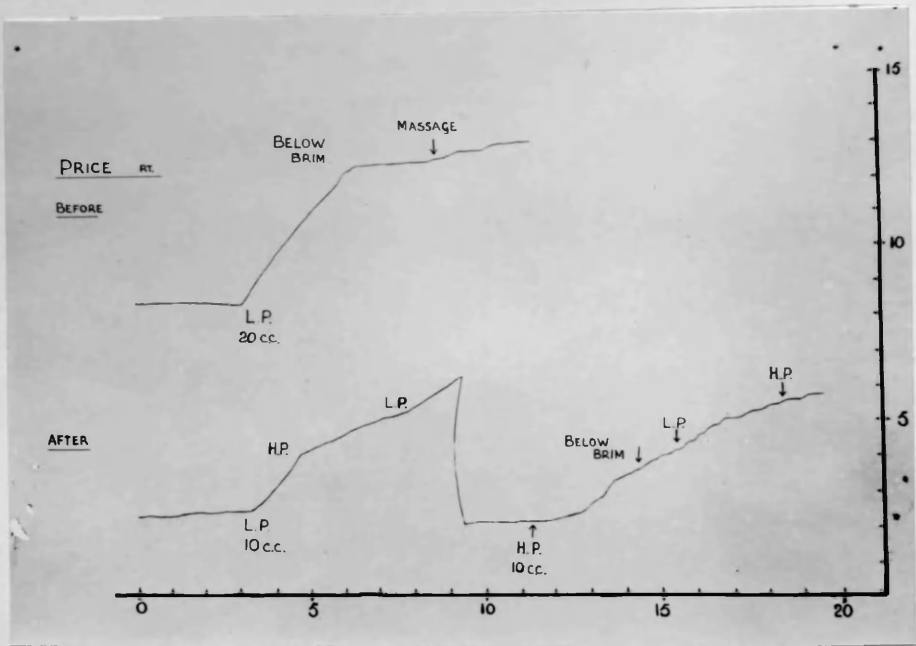


Fig. 86.

Fig.87. Tracings made in case no.11, before and after delivery, showing the marked falling off in the tone of the ureteral musculature which occurs after delivery.

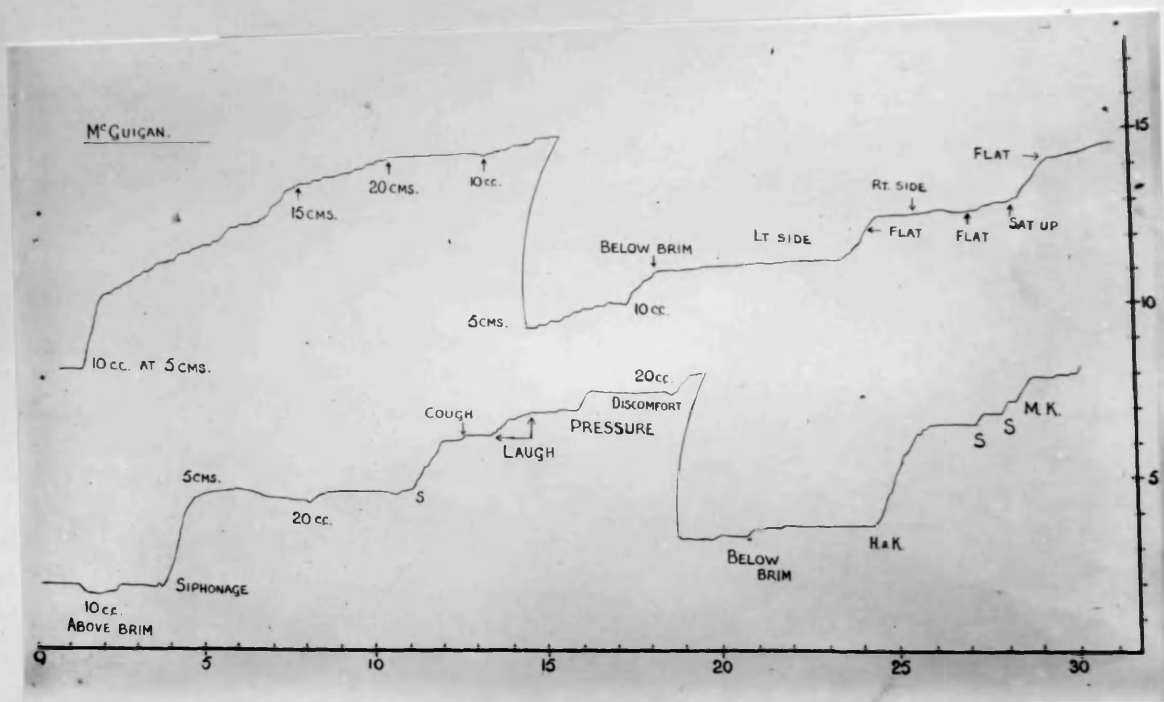


Fig. 87.

Fig.88. An intravenous pyelogram at 7 minutes in a primigravida in the 5th. month of pregnancy. There was acute pain due to spasm of the left renal tract, which appears normal.

Fig.89. An intravenous pyelogram at 7 minutes in a primigravida in the 8th. month, with severe right-sided pain. Acute kink of right ureter but no dilatation or delay in excretion.



Fig. 88.



Fig. 89.

Fig.90. An intravenous pyelogram in a multipara in the 6th. month. Dilatation of right kidney pelvis and kinking of ureter immediately below kidney pelvis. She had pain in the right iliac fossa.

Fig.91. An intravenous pyelogram in the 6th.month in a multipara. Marked kinking at ureteropelvic junction on both sides. Pain only in right kidney region.



Fig. 90.



Fig. 91.

Fig.92. An intravenous pyelogram at 7 minutes
in a primigravida at the 16th. week.
Delay in excretion in right ureter.

Fig.93. An intravenous pyelogram at 50 minutes
in the same case at the 16th. week.
Right ureter now shows for the first
time, narrowed to a point at the
level of the pelvic brim. Painful
spasm occurred at this narrow point,
which obstructed all but the
smallest catheter.



Fig. 92.



Fig. 93.

Fig.94. An intravenous pyelogram at 7 minutes in a multipara at the 7th. month. Delay in excretion on the left side, due to painful spasm of the uretero-pelvic junction.

Fig.95. An intravenous pyelogram at 7 minutes in a multipara at the 7th. month. Pain along course of right urinary tract. No delay in excretion in right tract, but several acute kinks.



Fig. 94.



Fig. 95.

Fig.96. (1) The percentage of cases admitted in each month of the year to the antenatal department which had urinary infection, for the first 2 year period.

(2) The percentage of cases admitted in each month of the year to the antenatal wards which had urinary infection omitting mild infections, for the second 2 year period.

(3) The percentage of cases admitted to the antenatal department with acute primary attacks of pyelitis, in each month of the year arranged according to the month in which the attack began, for the first 2 year period.

OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY. JUNE JULY. AUG. SEPT.

60
50
40
30
20
10

60
50
40
30
20
10

40
30
20
10

Fig. 97. An intravenous pyelogram in a multipara at the 7th. month of pregnancy. Enormous dilatation of the right urinary tract. Very little dilatation of the left. An attack of right-sided pyelitis followed the dilatation.



Fig. 97.

Fig.98. A photograph of the kidneys in case 16.
Multiple abscesses of right kidney.
Left kidney unaffected.



Fig. 98.

Fig.99. A microphotograph of a section of a renal papilla from the right kidney in Fig.98. Some of the collecting tubules are seen cut transversely and are packed with pus. x 100.

Fig.100. A microphotograph of one of the collecting tubules seen in Fig.98 cut longitudinally at a higher level. x 100.

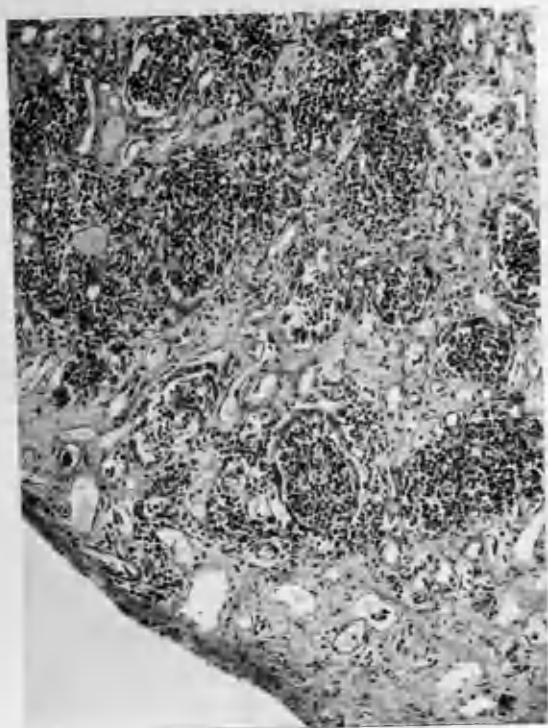


Fig. 99.

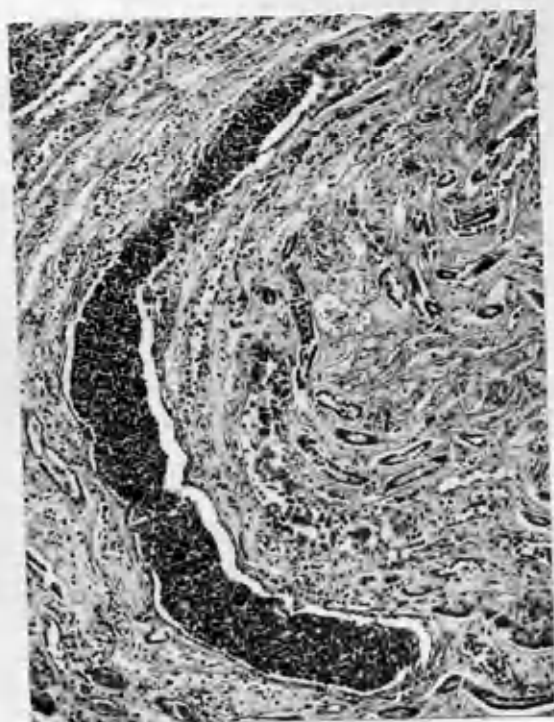


Fig. 100.

Fig.101. A microphotograph of the same papilla as in Fig.99, showing some tubules cut longitudinally and some transversely, at a lower magnification — x 7.5.

Fig.102. A microphotograph of the wall of the ureter in case no.27, which died of severe pyelitis. Marked destruction of the muscular layers and oedema of the submucosa. x 100.

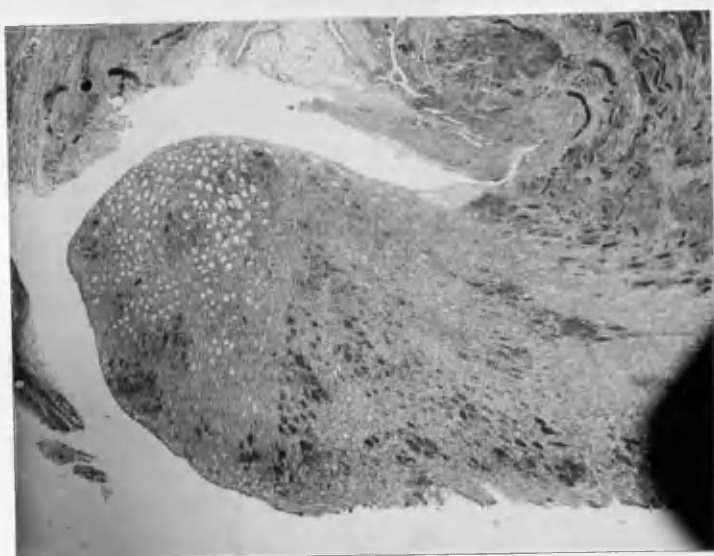


Fig. 101.

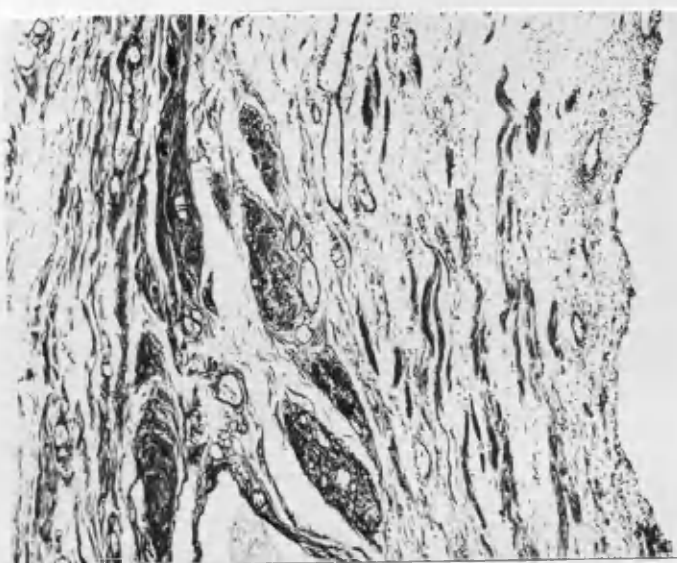


Fig. 102.

Fig.103. A photograph of the kidneys in case no.17. The right kidney is enlarged and contains multiple abscesses. There is blood clot in the kidney pelvis. Left kidney shows fan-shaped area of recent infection.

R.

L.

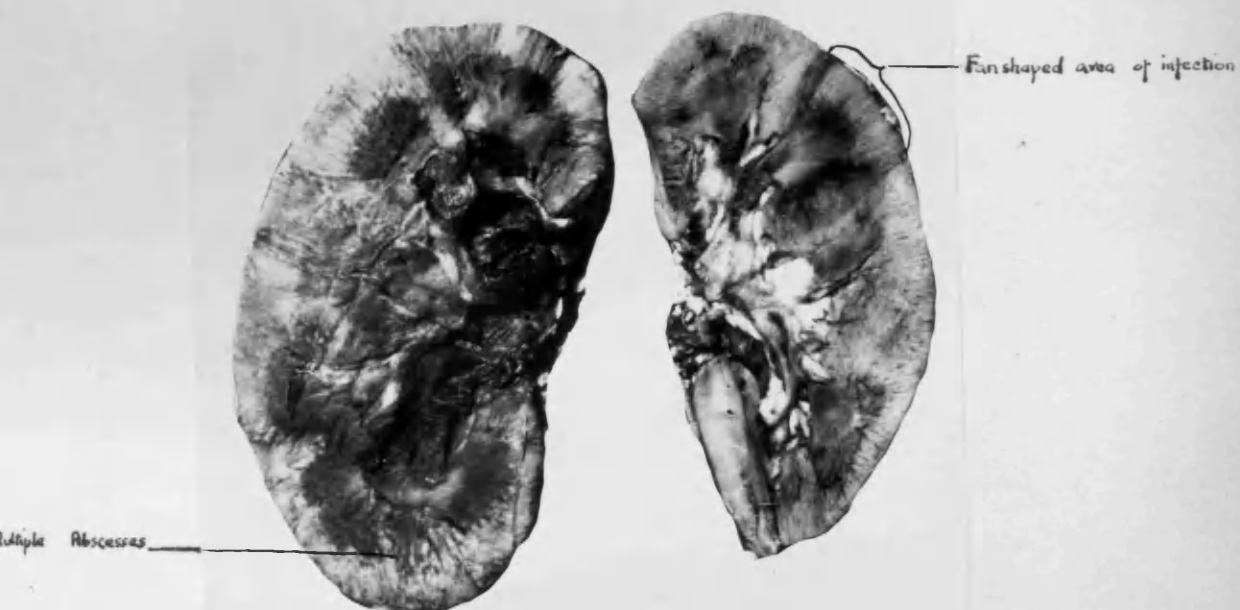


Fig. 103.

Fig.104. A microphotograph of a section
through the wall of the right
ureter in case no.17.
Extensive destruction of
tissue. x 100.

Fig.105. A microphotograph of a portion
of the left kidney pelvis in
case no.17. Slight oedema
and round-celled infiltration.
x 100.

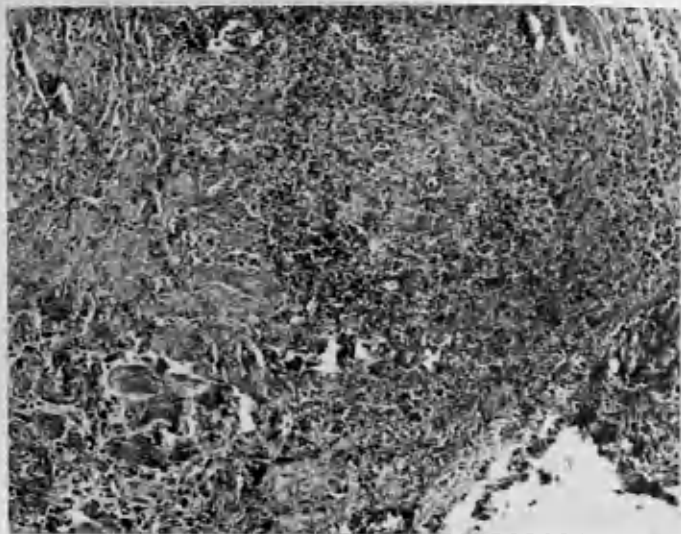


Fig. 104.



Fig. 105.

Fig.106. A photograph of the kidneys in case no.18. Right kidney much diminished in size and has multiple scars, due to healed pyelo-nephritis. Left kidney also has a few scarred areas.

L

R

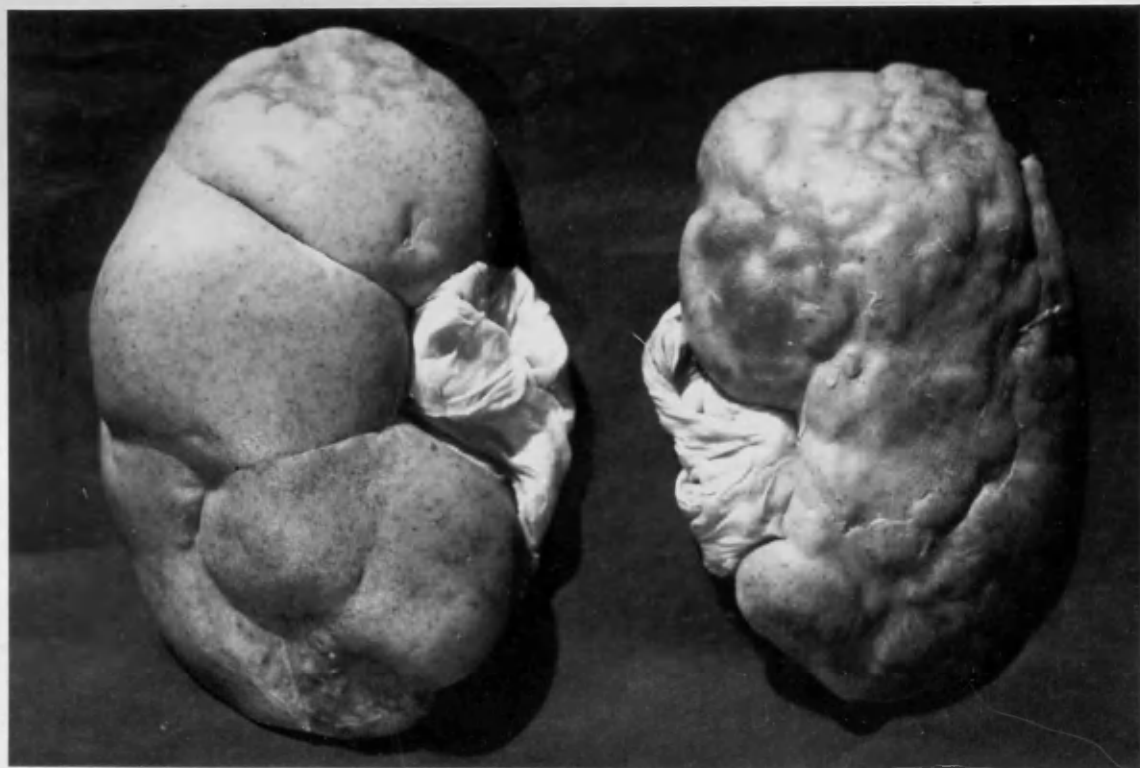


Fig. 106.

Fig.107. A microphotograph of a section from one of the scarred areas in the right kidney in Fig.106. Glomeruli clumped together due to massive destruction of tubules and many fibrosed. The surrounding tubules are comparatively healthy. x 100.

Fig.108. An intravenous pyelogram in a case of bilateral pyelitis, showing only moderate dilatation of the renal tracts on both sides. Even after $1\frac{1}{2}$ hours, shadow of right tract is faint, since the kidney function is poor and the ureter relatively active.

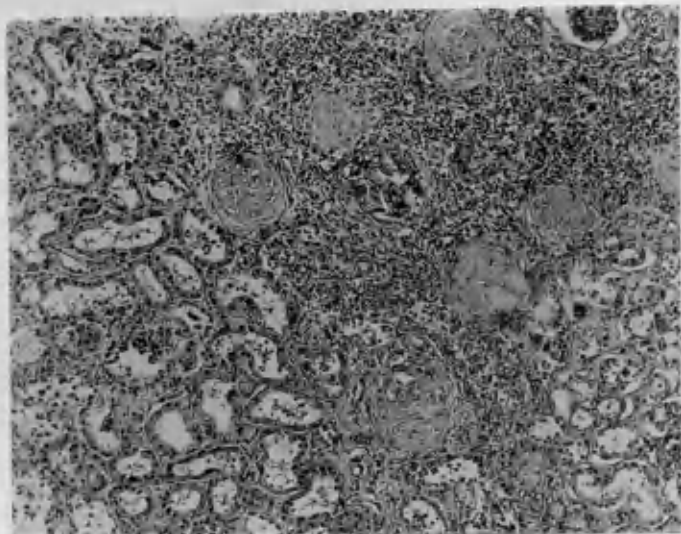


FIG. 107.



Fig. 108.

Fig.109. An intravenous pyelogram in a case of bilateral pyelitis. Left renal tract shows clearly down to the pelvic brim. Right tract, although less dilated than the left, is not so distinct.

Fig.110. An intravenous pyelogram in a case of acute pyelitis. Only moderate dilatation of both tracts. Pain was very acute.



Fig. 109.



Fig. 110.

Fig.111. An intravenous pyelogram in a case of acute right-sided pyelitis. Moderate dilatation of right tract, left normal.

Fig.112. An intravenous pyelogram in the 7th. month in case no.18. Left ureter slightly dilated. Only very faint shadow of right calyces showed at any time, indicating involvement of kidney function.



Fig. 111.



Fig. 112.

Fig.113. An intravenous pyelogram at $1\frac{1}{2}$ hours in a case of bilateral pyelitis. No shadow on the right side and enormous dilatation of left kidney pelvis, calyces and ureter seen. No urinary symptoms in this case.

Fig.114. An intravenous pyelogram in a case of bilateral pyelitis of the toxic type. The right urinary tract shows very faintly. The most dependent calyx was filled with pus which was aspirated through a catheter.



Fig. 113.



Fig. 114.

Fig.115. An intravenous pyelogram at 25 minutes
in a case of bilateral pyelitis.
Calyces only showing on left side.
On right side dilatation of calyces,
kidney pelvis and ureter.

Fig.116. An intravenous pyelogram at 7 minutes,
in the same case after drainage by
ureteral catheters. Dense shadow
of upper calyces on the right side
showing.



Fig. 115.



Fig. 116.

Fig.117. A retrograde pyelogram in the puerperium in case no.39. Ptosis of the right kidney with dilatation and atony of the urinary tract.

Fig.118. A retrograde pyelogram in the puerperium in case no.43. Both urinary tracts have returned to normal.



Fig. 117.



Fig. 118.

Fig.119. A retrograde pyelogram taken 1 year after end of 3rd. pregnancy in case no.44, showing moderate dilatation of calyces, kidney pelvis and ureter on right side.

Fig.120. An intravenous pyelogram in case no.45, in the 7th. month, at $1\frac{1}{2}$ hours, showing a very faint shadow of enormously dilated calyces and kidney pelvis on right side.



Fig. 119.



Fig. 120.

Fig.121. A retrograde pyelogram in a multipara with pyelitis of long standing, in the 4th. month, showing narrowing of both ureters at the level of the pelvic brim, which was found to persist in the puerperium.

Fig.122. A microphotograph of a section of the kidney pelvis from a case which died of pyelitis of the puerperium. Extensive inflammation. x 40.



Fig. 121.

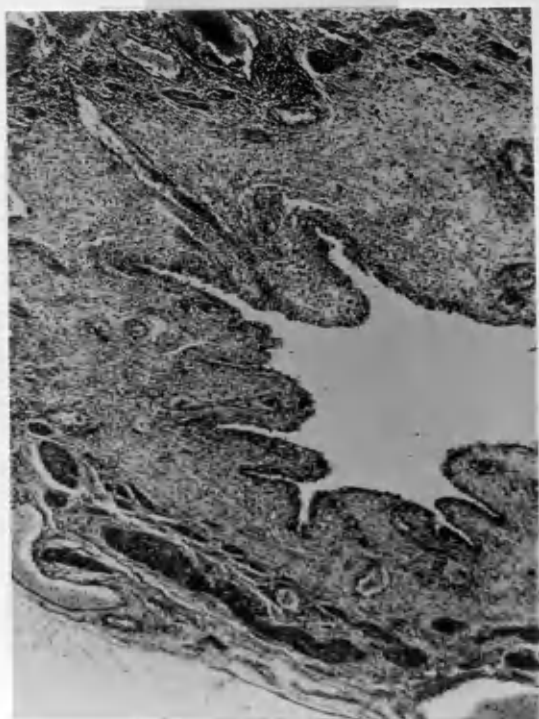


Fig. 122.

Fig.123. A microphotograph of one of the streaked areas of inflammation in the medulla of the kidney from the same case as in Fig.122. Extensive destruction of tubules.
x 40.

Fig.124. A microphotograph of the same area under higher magnification, showing pus in some of the tubules and gross destruction of others.
x 100.

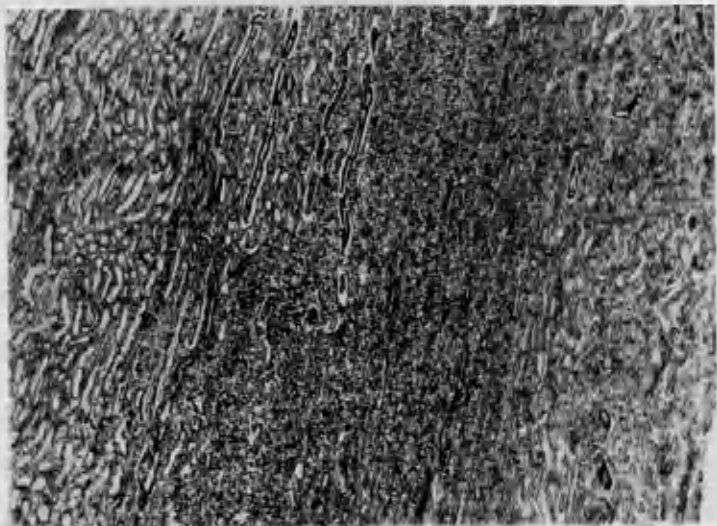


Fig. 123.

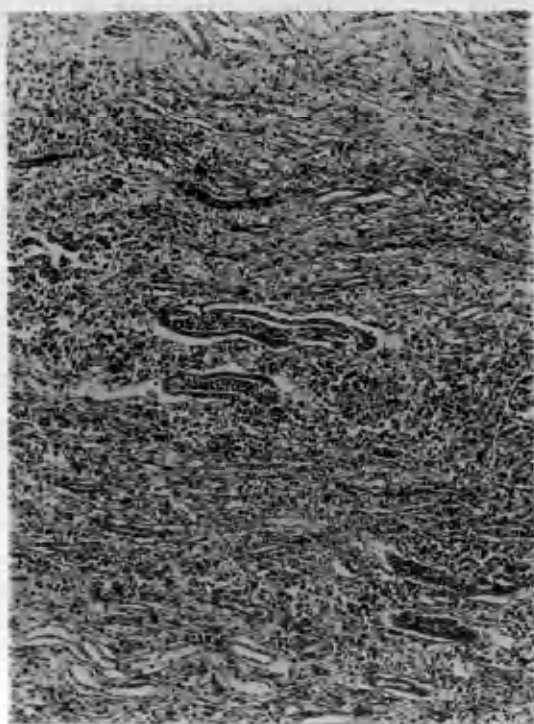


Fig. 124.

Fig.125. A microphotograph of a section from the cortex of the same kidney as in Fig.124, showing a fan-shaped area of pyelo-nephritis, with healthy kidney substance on either side of it. x 30.

Fig.126. A microphotograph of a section of the left ureter in a case which died on the 4th. day postpartum, showing acute necrosis of the mucosa and submucosa. x 40.

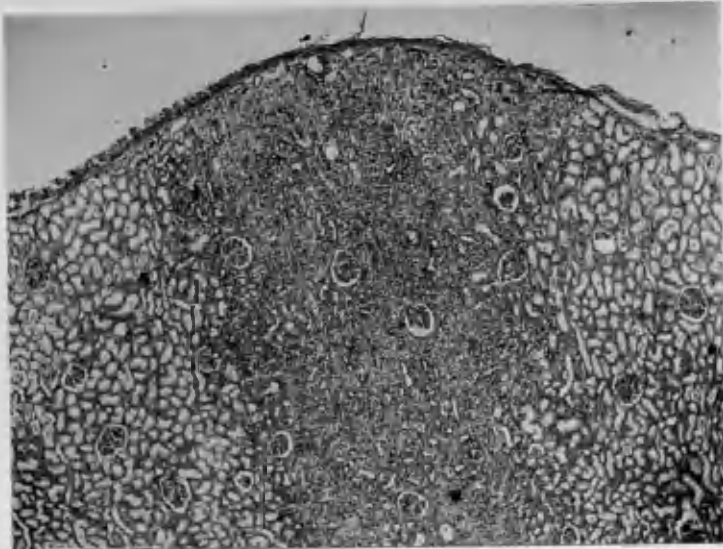


Fig. 125.

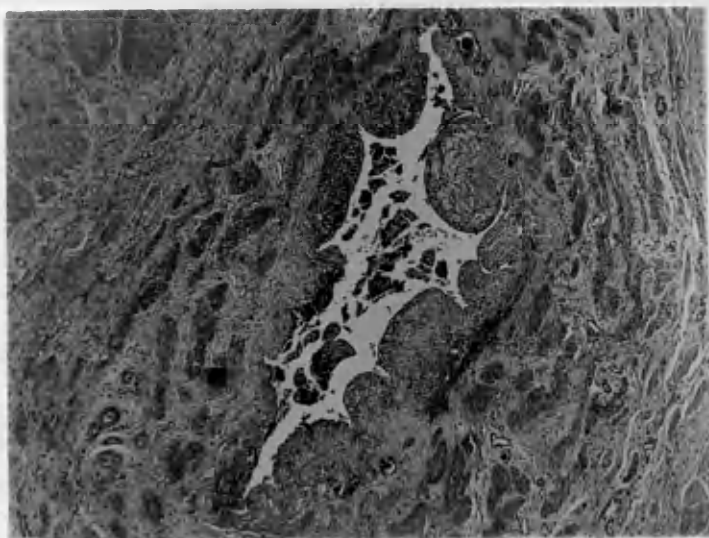


Fig. 126.

Fig.127. An intravenous pyelogram, at 20 minutes, in the 7th. month of pregnancy, in a case where the left kidney has been removed.

Fig.128. An intravenous pyelogram at the 4th. month of pregnancy, in a case with double kidney and ureter on the left side. 2 sets of calyces appear on the pyelogram, pointing inwards, indicating rotation of the kidney.



Fig. 127.



Fig. 128.

Fig.129. A photograph of one of the kidneys
in a case of congenital polycystic
disease.



Fig. 129.

Fig.130. A retrograde pyelogram in the 4th. month of pregnancy in a case of bilateral congenital cystic disease. Characteristic elongation of kidney pelvis.



Fig. 130.

Fig.132. Another retrograde pyelogram in the same case shows that this calyx contains a calculus.

Fig.131. A retrograde pyelogram in the 4th. month shows an enormous hydronephrosis in a horseshoe kidney. The ureter is undilated and crosses in front of a very dependent calyx.



Fig. 132.



Fig. 131.

Fig.133. A retrograde pyelogram on the 8th. day postpartum showing enormous dilatation of the calyces and kidney pelvis on the right side, and very little dilatation of the ureter. Changes are not characteristic of pregnancy.

Fig.134. An intravenous pyelogram at 1 hour, in a primigravida in the 5th. month, showing an enormous external hydro-nephrosis. The ureter is undilated and does not show.



Fig. 133.



Fig. 134.

Fig.135. An intravenous pyelogram at 1 hour in the 4th. month in a multipara, showing an enormous external hydronephrosis on the left side. The left ureter is undilated.

Fig.136. An intravenous pyelogram at 20 minutes in the 6th. month in the same case shows that the hydronephrosis on the left side is smaller and, as the ureter also shows on this plate, the kidney pelvis must be emptying more efficiently.



Fig. 135.



Fig. 136.

Fig.137. A preliminary X-Ray plate shows an enormous branching calculus filling the kidney pelvis and calyces on the right side, and a smaller calculus on the left side.

Fig.138. An intravenous pyelogram at the 3rd. month in a multipara shows a slight dilatation of the right urinary tract and no shadow on the left side, even at 2 hours. A large calculus is seen at the pelvic brim in the left ureter. No sodium iodide could be injected past it.



Fig. 137.



Fig. 138.

Fig.139. A preliminary plate in a primigravida in the 5th. month showing 2 small calculi in the pelvic portion of the right ureter.

Fig.140. An intravenous pyelogram at 60 minutes in the same case immediately after the preliminary plate shows enormous dilatation of the calyces, kidney pelvis and ureters.

Calculi



Fig. 139.



Fig. 140.

Fig.141. A catheter pyelogram in a multipara, at the 5th. month, showing obstruction to the right ureter just below the kidney. 2 calculi are seen in the kidney area.

Fig.142. A catheter pyelogram in a primipara, in the 6th. week postpartum, showing a calculus situated at the pelvic brim, but not causing obstruction to outflow.



Fig. 141.



Fig. 142.

Fig.143. An intravenous pyelogram in the 8th. month in a multipara, showing that the most dependent calyx in the left kidney gives no shadow even at 50 minutes, due to severe pyelo-nephritis affecting this area.



L
UC

Affected calyx

Fig. 143.

Fig.144. A microphotograph of a section of a renal papilla in a case of chronic pyelo-nephritis, showing engorgement of the capillary vessels. x 40.

Fig.145. A microphotograph of a section of a small portion of the wall of the ureter in a similar case, showing engorgement of vessels, which are plainly seen projecting into the lumen of the ureter.

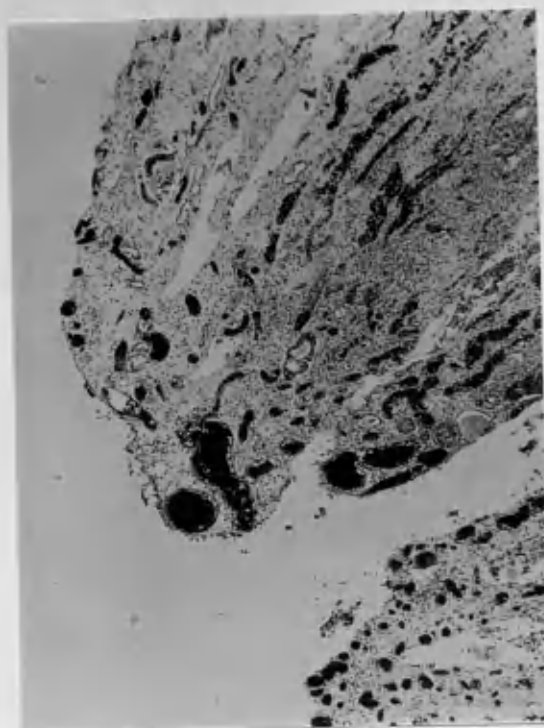


Fig. 144.



Projecting blood vessel

Fig. 145.

The URINARY TRACT in PREGNANCY
and the PUERPERIUM
with special reference to
PYELITIS of PREGNANCY

by

DUGALD BAIRD.

APPENDIX B.

Case sheet no.1. Mrs.C. aet.17 1st pregnancy.

2nd mth. Admitted with hyperemesis, which cleared up quickly.
 6th " Right sided pyelitis, but not confined to bed.
 F.T. Normal delivery in hospital, child alive.
 3rd mth. postpartum. Urine sterile.

Urological Investigation.

Chromocystoscopy.

Intravenous Pyelography.

2nd.mth.	I.C.no movement at either orifice for 10 mins.when I.C. in good concentration and big puffs.	<u>Fig.43.</u> dilatation and kinking of ureters.
4th	I.C. left side 5 mins. right " " "	<u>Fig.44.</u> no dilatation seen.
5th.	I.C. left side 23 " right " 20 "	<u>Fig.45.</u> dilatation and kinking of both ureters.
6th.	I.C. left side 7 " right " none in 15 mins. Urine heavily infected.	
7th.	I.C. left side 5 mins. right " none in 17 mins.	<u>Fig.46.</u> dilatation of left ureter same as at 5th mth. more dilatation of right tract,affecting calyces and kidney pelvis as well as ureter.
8th	I.C. left side 5 mins. right " none in 17 mins.	
5th month p.p.	I.C.left side 5 mins. right " none in 12 mins. irregular action of right ureter indicating atony. Urine sterile.	Dilatation of right urinary tract.

Second Pregnancy one year later.

Well during whole pregnancy. Normal delivery at full time.

Chromocystoscopy

Tone of Ureter.

4th mth.	I.C. left side 8 mins. right " none in 11 mins.	right 20cms.
6th	I.C. left side 5 mins. right " " "	right 22cms.
	Action of both ureters regular.	
7th	I.C. left side 5 mins. right " " "	left right 20cms.
	Intravenous pyelogram shows dilatation same as at 7th mth. of first pregnancy.	
8th	I.C. left side 4 mins. right " " "	left 36cms. right 22cms.

2.

9th mth. I.C. left side 4 mins.	left	60cms.
right " " "	right	60cms.
8th day p.p. I.C. left side 5 mins.	left	20cms.
right " 10 "	right	10cms.

very irregular action of right ureter.

In the second pregnancy there was no stasis although there was the same degree of dilatation as in the first, when there was considerable stasis. The tone of the ureter in the second pregnancy was poor but improved in the 9th month. After delivery it diminished very quickly, especially on the right side.

Case sheet no.2. Mrs.G. aet.27 2nd pregnancy

First pregnancy was uneventful. Well during the second apart from slight vomiting in the third month. Normal delivery at full time.

Urological Investigation.

Chromocystoscopy.

Intravenous Pyelography.

- | | | |
|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3rd mth. | I.C.left side 7 mins.
right " 18 " , only
after abdominal massage.
No movement of orifice till
massage. | Kinking and dilatation of
both ureters. |
| 4th | I.C.left side 8 mins.
right " 10 " , very
irregular action. | |
| 5th | I.C.left side 5 mins.
right " 7 mins. very
irregular action. | <u>Fig.47.</u> enormous dilatation
and kinking of right
urinary tract. Also on
left side to less degree. |
| 6th | I.C.left side 5 mins.
right " 8 " , irregular
action. | |
| 9th | I.C.left side 5 mins.
right side concentration of
dye too poor to see efflux but
ureter now contracting regularly
every 10-15 secs. | <u>Fig.48</u> . on left side kinks
of ureter have now disap-
peared. Dilated part
of right ureter not
seen as it is com -
pressed against the
psoas muscle. |
| 4th day p.p. | I.C.left side 5 mins.
right " no movement till
13 mins.when huge efflux came
as in 3rd mth. | |

These findings show that atony was present at the 3rd month of pregnancy , diminished as pregnancy advanced and reappeared in the puerperium.

Case sheet no.3.

Mrs. McF.

aet 27

2nd pregnancy.

The first pregnancy ended in abortion at the 3rd month.
Well during whole of second pregnancy . Normal full time delivery.

Urological Investigation.Chromocystoscopy.Intravenous Pyelography

3rd mth.	I.C. left side 5 mins. right " 7 " no movement until then.	
4th	I.C. left side 4 mins. right " " "	Fig.49. Slight kinking of both ureters with slight dilatation of the right.
5th	I.C. left side 6 mins.irregular action. right side 12 mins. irregular action.	Fig.50. Dilatation and kinking of both urinary tracts ,especially the right
6th	I.C.left side 9 mins.irregular action right side 12 mins. irregular action.	
7th	I.C. left side 9 mins. right " 17 " , concentration poor.	
8th	I.C. left side 4mins. action more regular. right side none at 17 mins. but frequent contractions.	Fig.51. Left urinary tract now undilated and straight. Right Calyces and kidney pelvis more dilated. Right ureter very faint.

There was primary atony in the right ureter at the 3rd month, recovery at the 4th month and atony of both ureters again in the 5th month. Thereafter the left ureter improves in tone and becomes less kinked and dilated, but on the right side although the greater activity of the ureter at the 8th month indicates improvement in tone , there is greater delay in emptying due to increased obstruction to outflow. The point of obstruction has been transferred to a point just below the kidney, so that kidney function has been more affected.

Case sheet no.4.

Mrs.McF.

aet 21

2nd pregnancy.

Severe attack of pyelitis with first pregnancy, which caused miscarriage in the 7th month.

Well during second pregnancy and urine sterile.

Urological Investigation.

Chromocystoscopy.

Intravenous Pyelography.

4th mth. I.C.left side 5 mins.
right " 6 "

6th I.C.left side none at 18 mins. right " " " " " " Fig.52.at 4 mins.both tracts appear undilated, but ureters kinked.
massage caused prolonged contractions and I.C. appeared in good conc. Fig.53.at 20 mins. both tracts very dilated down to pelvic brim. A plate taken a few minutes later showed same appearances as in fig. 52.

7th Fig.54.less dilatation of left side than in fig.53, but more of right side, with calyces and kidney pelvis constantly distended

8th I.C.left side 6 mins.
right " none in 15 mins.

9th I.C.left side 5 mins. right " none in 18 mins. Fig.55. left urinary tract still less dilated but ureteral orifice seen to move frequently. Fig.55. left urinary tract still less dilated but ureter displaced laterally.
Right side same as fig.54.

Intermittent emptying of both ureters occurred at the 6th month. As pregnancy advanced the function at the left side improved and dilatation diminished. The ureter became displaced and flattened along the outer border of the psoas muscle. On the right side the calyces and kidney pelvis became constantly dilated and emptied by overflow. The right ureter became compressed throughout the middle third, instead of only at the pelvic brim as at the 6th month.

Case sheet no.5. Mrs.U. aet.24 3rd pregnancy.

Well during both previous pregnancies, normal deliveries.
Well throughout the present pregnancy. Normal delivery at full time.

Urological Investigation.

Chromocystoscopy.

Intravenous Pyelography.

2nd mth.I.C.left side 4 mins.
right " " "

5th I.C.left side 4 mins. Fig.56. Slight kinking and
right " none in 15 mins. dilatation of both ureters,
till after massage when conc. good shadow on both sides in
good. 5 mins.

8th I.C.left side 4 mins.
right " " " regular
action.

9th I.C.left side 4 mins. No more dilatation than in
right " " " fig.56. Right ureter does not
vigorous efflux at both show down to pelvic brim.
sides.

The moderate degree of atony and stasis present in the right urinary tract at the 5th month did not persist and completely disappeared by the 9th month.

Case sheet no.6.

Mrs.McE.

aet.18

1st pregnancy

Well throughout the pregnancy , normal delivery at full time.

Urological Investigation.Chromocystoscopy.Intravenous Pyelography.

4th mth. I.C.left side 5 mins.

right " none in 12 mins.

Fig.58.at 7 mins.left side shows slightly dilated and on the right calyces, kidney pelvis and only small part of ureters show dilated.

Fig.59.at 30 mins.shows right ureter dilated down to pelvic brim,slightly kinked but not displaced laterally.

6th I.C.left side 5 mins.

right " none in
12 mins.

Fig.60.at 7 mins.shows left tract unchanged and only calyces on right side.

Fig.61.at 30 mins.shows right kidney pelvis clearly defined and more dilated.

Fig.62.at 40 mins. shows right ureter no more dilated but displaced laterally.

8th I.C.left side 4 mins.

right " none in
12 mins.

9th

Fig.Left side still unchanged .Further delay in appearance of shadow of right calyces , which only becomes as dense at 60 mins.as it was at 40 mins. in the 6th month. No more dilatation of right side.

8th day p.p.I.C.left side 5 mins.

right " 7 "

motionless till then,very
irregular action.

6th mth. Urea concentration of urine from right kidney	1.84%.
left " "	2.0%

8th mth. Tone of right ureter 38cms.

8th day p.p." " " " 10cms.

Fig.79: is a tracing made with a catheter in the right ureter at the end of the 4th month and it demonstrates that even at this stage the uterus is compressing the right ureter at the pelvic brim.

In this case the ureteral tone remained good throughout pregnancy but progressive delay in excretion by the kidney occurred as pregnancy advanced. In the puerperium the tone of the ureter rapidly diminished.

Still under observation undelivered. Well so far despite severe mitral stenosis.

Urological Investigation.

Chromocystoscopy.

Intravenous Pyelography.

I.C.

3rd mth. left side 3 mins.
right " 3 "

4th I.C. left side 5 mins.
right " 12 "
irregular action, but
good conc.

5th I.C.left side 4 mins.
right " none in 12
mins.I.C.in very poor
conc.tapped with catheter
above brim.

Fig.63. at 7 mins.left side shows normal,only faint shadow of calyces on right side.

Fig.64.at 20 mins. kidney pelvis and calyces on right side show moderately dilated.

7th. I.C. left side 4 mins. At 25 mins. no shadow of right
right " none in 12 side but later plates show no
mins. but frequent efflux. increase in degree of dilatation.

Tone of ureter.

Urea concentration.

3rd mth. right 50sms.+(2ccs.fluid
injected caused pain.)

4th right 50cms.+

5th right 56cms.+

bladder	0.69%
right kidney	0.42%
left "	1.14%

7th	right	65cms.
	left	" "

bladder	0.75%
right kidney	0.41%
left kidney	1.16%

The low figure for urea concentration of the urine from the right kidney and the poor shadow obtained by intravenous pyelograph indicates serious disturbance of kidney function. Tone of right ureter is unusually good.

Case no.8.

Mrs.M.

aet.21

1st pregnancy.

Admitted at full time for Caesarean Section for contracted pelvis Well during the pregnancy. Caesarean Section performed and puerperium normal.

Urological Investigation.

Chromocystoscopy

F.T. I.C.left side 5 mins.
right " none in 11
mins. frequent movements
of right orifice.

10th day p.p.
I.C.left side 5 mins.
right " none in 12
mins.,no movement of
right orifice.

1 mth.p.p.
I.C.left side 4 mins.
right side" "

Tone of ureter.

F.T. right 26cms.
left 32cms.

10th day p.p.
right 10cms.

1 mth.p.p.
right 16cms.

5 mths.p.p.
right 30cms.

Intravenous Pyelography.

Fig.65. Kinking, dilatation and lateral displacement of both ureters. Calyces and kidney pelvis affected on right side only.

Fig.66. Dilatation on right side still present.Lateral displacement has disappeared.

Urea Concentration.

right kidney 2.025%
left " 1.75%

bladder 1.25%
right kidney 1.25%
left " 1.71%

At one month after delivery the stasis in the right urinary tract had quite disappeared while the tone of the ureter was still very poor. The figures for urea concentration show that kidney ~~fun~~ function is not much impaired. The higher figure for the right kidney is really due to delay in excretion as the concentration on the left side has begun to diminish before the right has reached its maximum.

Case sheet no.9.

Mrs.W.

aet.20

1st pregnancy.

Well during pregnancy. Normal delivery and puerperium.

Urological Investigation.Chromocystoscopy.Intravenous Pyelography.

2nd mth. I.C. left side 5 mins.
 right " 9 "
 irregular action at
 both sides, especially
 the right.

Fig.70. Left side normal, right
 kidney pelvis and calyces dilated.
 Kinking at right ureteropelvic
 junction.

4th I.C. left side 5 mins.
 right " " "
 regular action at both.

6th I.C. left side 4 mins.
 right " none in
 13 mins.

Fig.71. At 7 mins. left urinary tract
 shows undilated, extremely faint
 shadow of dilated calyces on right
 side.
 Fig.73. At 75 mins. right ureter
 shows for first time.

8th I.C. left side 7 mins.
 right " none in
 13 mins.

Fig.74. left urinary tract now dila-
 -ted and displaced laterally, right
 tract unchanged.

8th day p.p.

I.C. left side 9 mins.
 right " none in
 12 mins.

Tone of ureter.

4th mth. right 40cms.

6th right 50+cms.

8th right 50+cms.

8th day p.p. right 10cms.

There was irregularity of action of both ureters in the early months, which recovered at the 4th month. Marked delay occurred at the right side in the 6th month, mostly due to delay in excretion by the kidney. Dilatation of left ureter at the 8th month took place. There was sudden loss of tone in the right ureter in the puerperium.

Case sheet no.10.

Mrs.P.

aet.21

1st pregnancy.

Admitted in 9th month because of albuminuria, haze of albumen in the urine and B.P. 160/110. Labour was induced and the puerperium was normal.

Urological Investigation.

Chromocystoscopy.

Intravenous Pyelography.

9th mth. I.C.left side 4 mins.
right side 5 "

3rd day p.p. I.C.left side 5 mins.
right " none in 10 mins.

14th day p.p.I.C.left side 7 mins.
right " 9 " irregular action at both sides.

2mths.p.p. I.C.left side 5 mins.
right " none in 10 mins. good conc. through a catheter.

Tone of ureter.

Graphic Record

3rd day p.p. right 12-14 cms.

14th day p.p. right 8 cms.

2 mths.p.p. right 16 cms.

Fig.86.,upper tracing, made a few days before onset of labour with catheter in right ureter, shows that there was obstruction at the pelvic brim.

Fig.86,lower tracing, made 12th day p.p. shows that obstruction at pelvic brim no longer occurs.

In this case there was obstruction at the pelvic brim without delay in excretion. The ureteral tone recovered very slowly in the puerperium.

Case sheet no.11

Mrs McG.

aet.21

1st pregnancy.

Contracted pelvis. Well during the pregnancy and had Caesarean section performed. Puerperium normal.

Urological Investigation.

Chromocystoscopy.

Tone of ureter.

F.T. I.C.left side 6 mins.

right " " " regular action right 26cms.
at both sides.

9th day p.p. I.C.left side 5 mins.

right " none in 11 mins. right 10cms.
very little movement, catheter
tapped I.C.above pelvic brim.

Fig.87, upper tracing, was made at full time with a catheter in the upper half of the right ureter. With the pressure at 5cms. 10 ccs. of acriflavine were injected and an abrupt rise of the lever occurred, after which the contractions became intermittent instead of continuous. The pressure against which the ureter was acting was raised to 15 cms. and excretion still continued. It was raised to 20 cms. and excretion stopped (horizontal line). On injecting 10ccs of acriflavine, excretion began again even against 20 cms. pressure. Pressure was then reduced to 5 cms. and 10 ccs of acriflavine again injected. This caused a continuous rise in the lever, till the catheter was pulled below the pelvic brim when secretion stopped. At the point indicated the patient was put in the left lateral position, when excretion of urine again occurred. Very soon after turning her on to the back the excretion stopped. Putting her in the right lateral position did not cause excretion to restart. Sitting up caused excretion and lying flat again diminished the rate of flow. Therefore in this case the activity of the ureter is fairly good and there is no delay in excretion, (indigocarmine excretion time 6 minutes). The ureter is compressed at the level of the pelvic brim and force is required to expel urine past that point. This is only accomplished when the ureter is completely filled.

Fig.87, lower tracing, was made on the ninth day postpartum with a catheter in the upper half of the right ureter. With no pressure excretion did not occur and 10 ccs of acriflavine injected caused no response. At negative pressure rapid excretion occurred but when the pressure was raised to 5 cms. fluid ran back into the ureter. 20 ccs. injected caused very little response. Sitting up caused immediate excretion and coughing and laughing caused a series of small waves. Pressure on the abdominal wall had a similar effect. On pulling the catheter below the pelvic brim, excretion stopped but was re-established by placing the patient in the hands and knees position or by getting her to sit up.

These tests indicate that the ureter is very susceptible to outside pressure and responds very poorly to distension of its lumen, indicating very poor tone of the ureteral musculature. This is in marked contrast to what is found before delivery.

Name CRAWFORD

Age 13

Ward _____

Physician _____

Journal _____

Room _____

Date of Admission

27.9.33

Diagnosis _____

Temp. _____

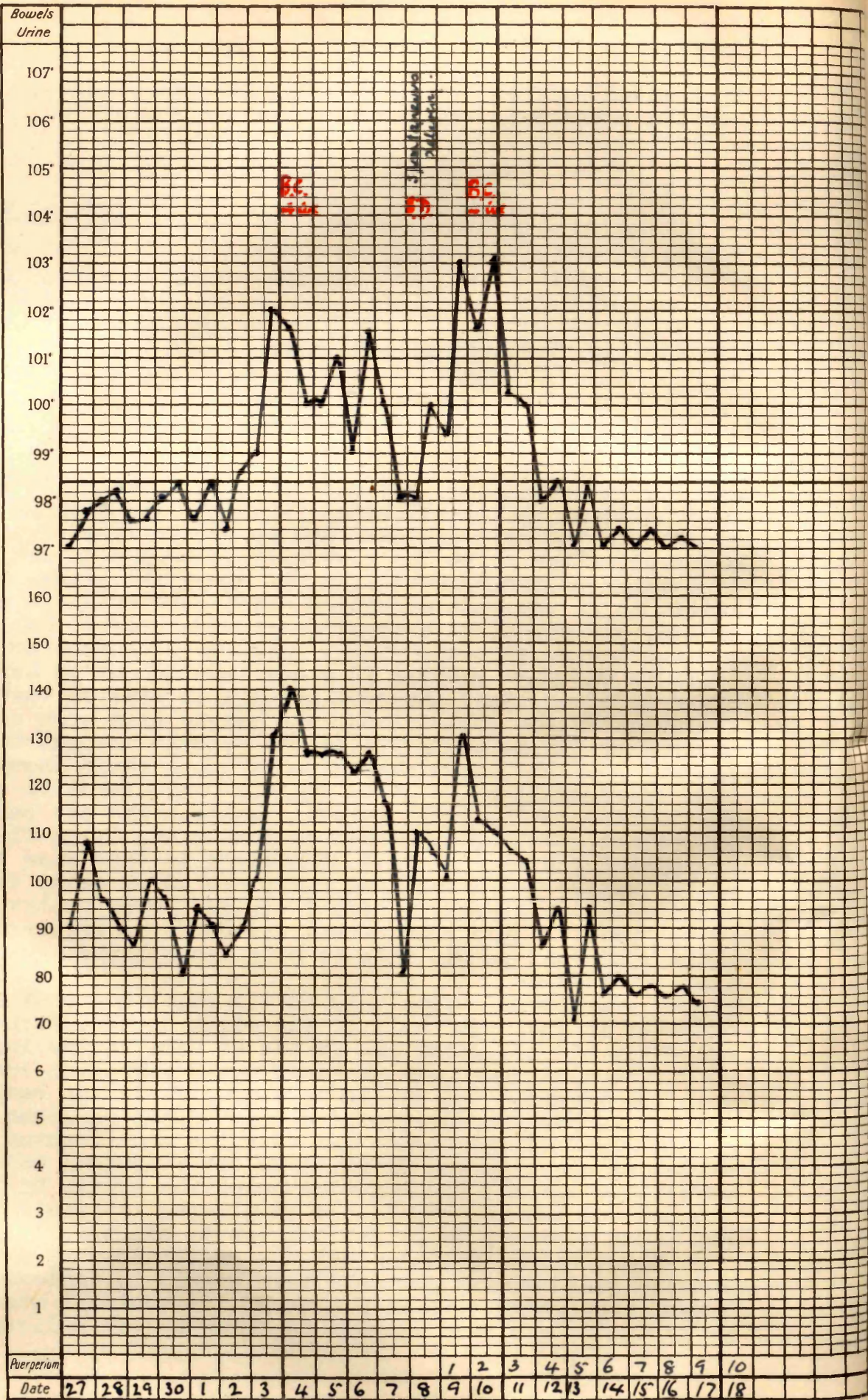
Case no 12

Pulse _____

Fundus _____

and/or

Albumen _____



35 weeks pregnant.

Present pregnancy. Well. Admitted because of age for medical induction.

19-10-33. Dismissed.

right " none in 6 mins., catheter then passed above pelvic brim and in position for 4 mins. before dye appeared.

7-10-33. " Bladder- abundant pus and Strep.faecalis, urea 0.88%

1.	Rt. ureter	a few pus cells and "	"	"	"	0.55%
2.	"	"	"	"	"	0.56%

1. <u>Lt.ureter</u>	sterile	"	1.12%
2. <u>" "</u>	"	"	1.10%

Vaginal swab - pure growth of Strep.faecalis.

4-10-33. Blood Culture- pure growth of Strep.faecalis.

10-10-33. " " sterile.

Name Mrs G.
Age 35
Ward _____
Physician _____
Journal _____
Room _____

Date of Admission
29.8.33
Diagnosis _____
Temp _____

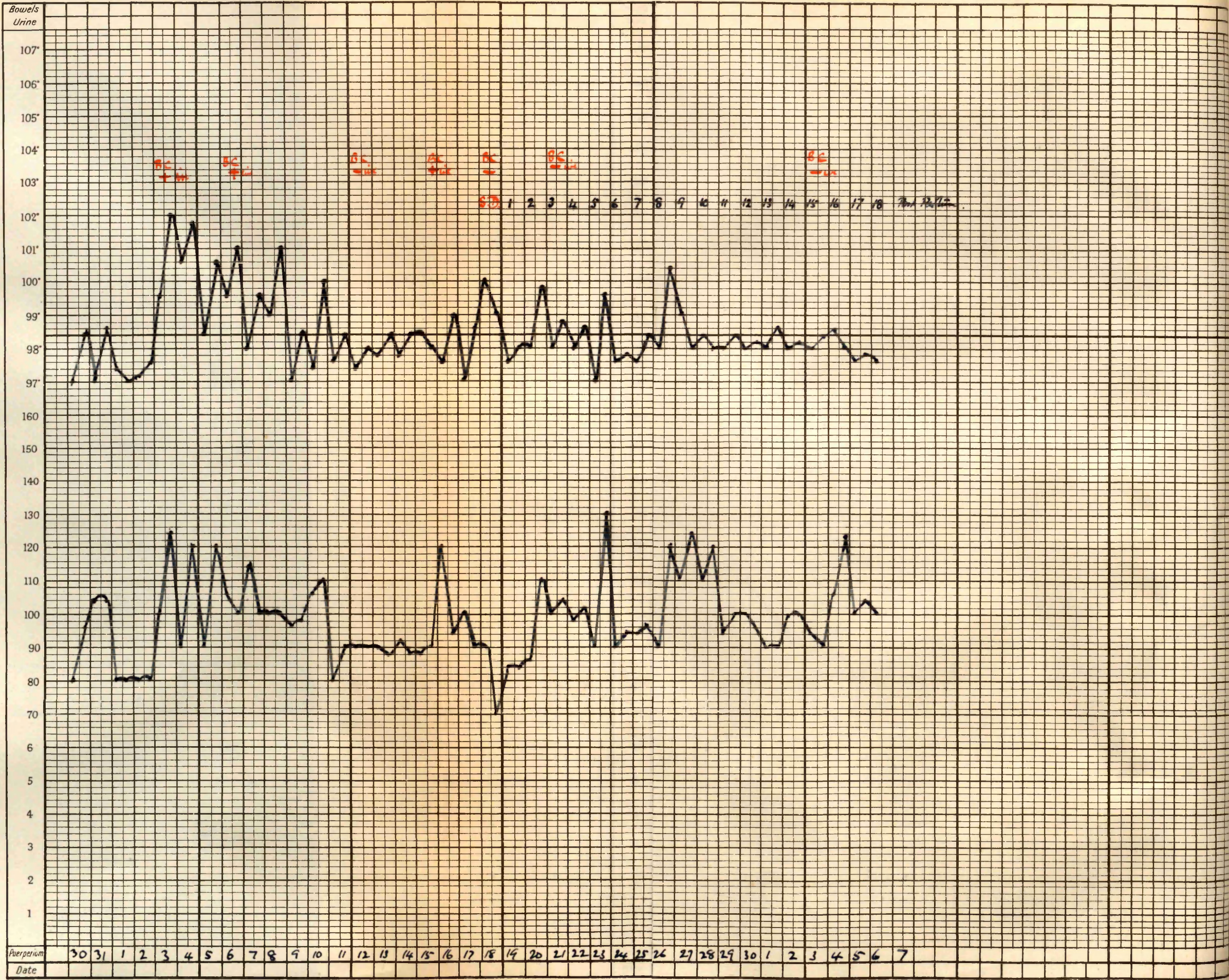
CASE no. 13.

Pulse _____

Fundus _____

and/or

Albumen _____



Case sheet no.13. Mrs G. aet 35 3rd pregnancy

29-8-33. Admitted. L.P.25-1-33 31 weeks preg.

Obstetric History. 1st- eclampsia, stillborn.

2nd - well , full time, alive.

Present Pregnancy. Well until 2 weeks ago when albuminuria discovered.

Examination. No oedema. B.P.140/115. Albumen $\frac{1}{2}$ part

Calomel and mag.sulph. nightly.

2-9-33. Sudden severe pain in both sides, with a feeling of irritation of bladder.

3-9-33. Rigor and pain on right side ,vomiting severe

4-9-33. Repeated rigors.

6-9-33. Abdomen distended due to flatulence. Very tender over right kidney.

Condition gradually improved.

16-9-33. Rigor and vomiting.

18-9-33. Labour began. 5 hours. Spontaneous delivery, 3 lbs. dead. Puerperium uneventful.

8-10-33. Dismissed well.

Bacteriology.

1-9-33. Urine sterile.

4-9-33. Urine abundant pus and coliform organisms.

23-9-33. Bladder urine abundant pus and B.coli.

Rt.ureter urine abundant pus and a few B.coli.

It. " " occasional pus cell and coliform bacillus.

Vagina abundant pus and B.coli.

3-9-33. Blood culture growth of B.coli.

6-9-33. " " " " "

12-9-33. " " sterile.

16-9-33. " " growth of B.coli.

18-9-33. 21-9-33. 3-10-33. Blood culture repeatedly sterile.

Types of coliform organism present.

Urine. ++-7+AC++ Vagina. ++-++AC++

Blood. ++-++AC++ Faeces. ++-++AC++

Patient's serum agglutinated all organisms to 1/800.

Urological Investigation.

23-9-33. 5th day p.p. Cystitis. I.C.left side 11 mins.

right " " " cone good
and vigorous efflux. Time
would probably have been less
but for difficulty in washing
bladder clear.

Name Mrs F.
 Age 24
 Ward _____
 Physician _____
 Journal _____
 Page _____
 Date of Admission 5.12.32
 Diagnosis _____
 Temp. _____

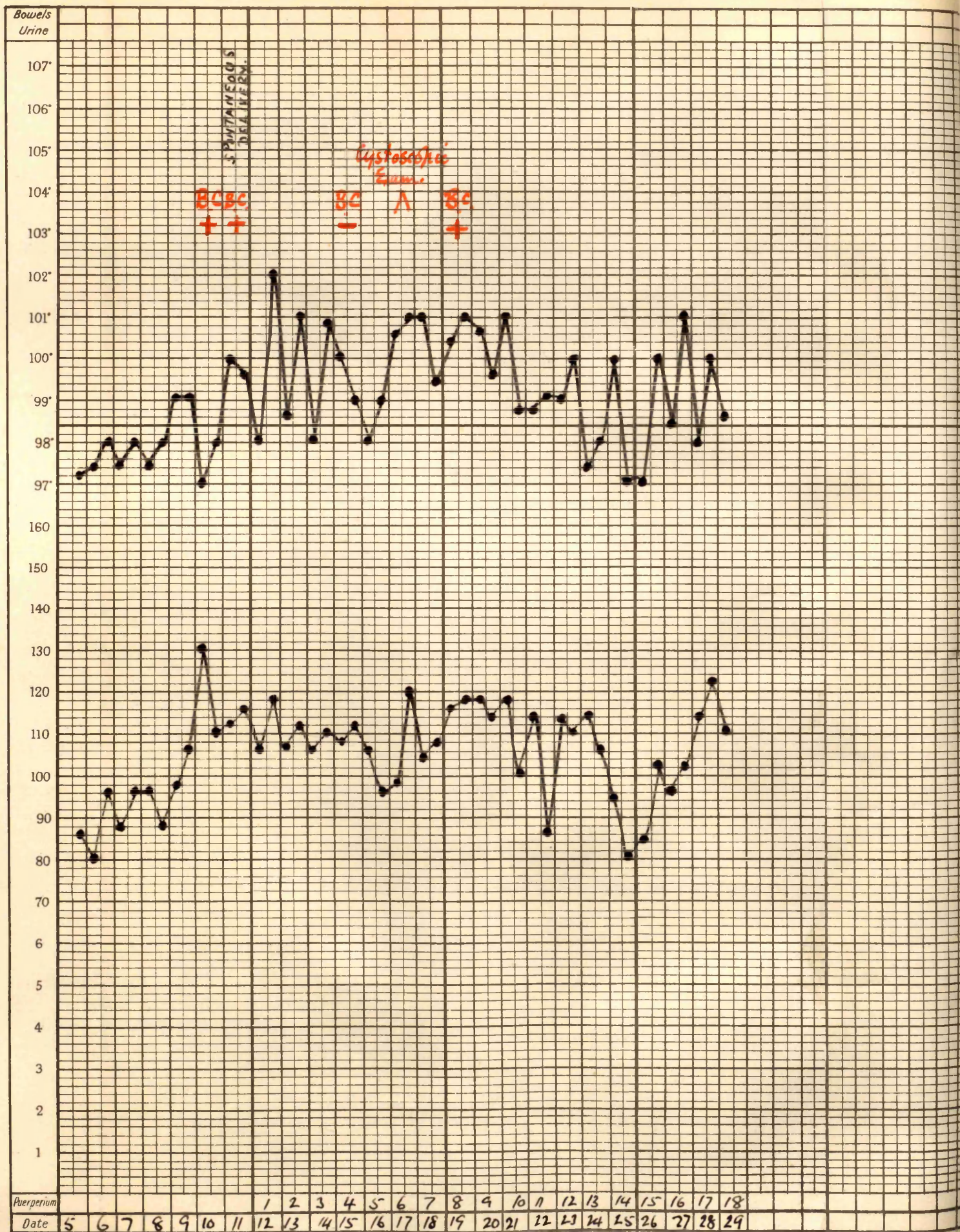
Case no. 14.

Pulse _____

Fundus _____

and/or

Albumen _____



Bacteriology.

Urine. ++-++AC++ Vagina ++-++AC++

Blood. ++-++AC++ Faeces. ++-++AC++ and ++-+-AC++

Urological Investigation.

16-12-32. 5th day p.p. Vagina sloughing. Bladder heavily infected.
mucosa very oedematous. I.C. left side 8 mins.
right " 9 "
Catheters passed to both sides and tone found to be poor.

Name Miss McG.

Age 35

Weight _____

Physician _____

Journal _____

Page _____

Date of Admission

3. 2. 33

Diagnosis _____

Treatment _____

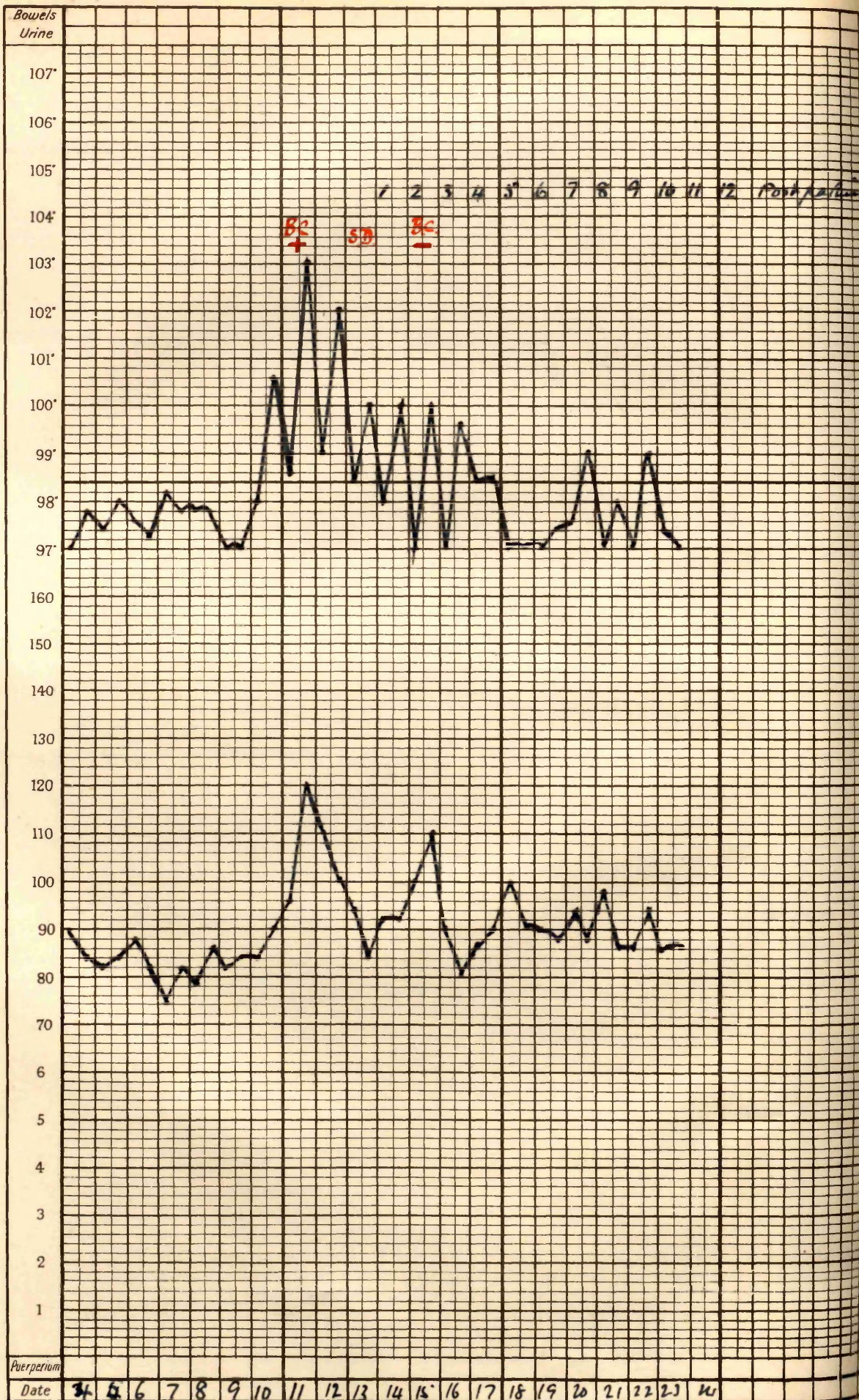
Case No. 15.

Pulse _____

Fundus _____

and/or

Albumen _____



Case sheet no.15.

Mrs McG.

aet.35

9th pregnancy

3-2-33. Admitted. L.P. Beginning of July, 1932. 31 weeks preg.
 Obstetric history. 6 normal full time pregnancies.
 2 abortions.

Present pregnancy. Swelling of the face and hands for 14 days,
 dimness of vision, epigastric pain and vomiting,

Examination. Oedema marked, B.P. 200/155. Urine 12 parts Esbach.

5-2-33. Severe epigastric pain.

7-2-33. Bowels acting freely, as often as 6 times in 24 hours.

10-2-33. Severe epigastric pain and a rigor.

11-2-33. Blood culture +ve. Membranes ruptured artificially.

13-2-33. Spontaneous delivery. 1 hour in labour. 3lbs. stillborn.

Distinct tenderness over left kidney, pain on micturition.

Bacteriology.

4-2-33. Urine sterile.

10-2-33. Coliform organisms isolated from urine, vagina, blood and faeces.

Types of organism present.

Urine (1). ++++AC-+ (2). +-++AC++^x

Vagina. (1). ++++AC-+ (2). +-++AC++

Blood. ++++AC-+

Faeces (1). ++++AC-+ (2) +-++AC++^x (3) A-AA----

Name Ann R.
 Age 34
 Weight _____
 Physician _____
 Journal _____
 Page _____
 Date of Admission 23.11.33
 Diagnosis _____
 Temper _____

Case. no. 16.

Pulse _____

Fundus _____

and/or

Albumen _____



Case sheet no.16. Mrs R. aet.34 8th pregnancy

23-11-33. Admitted L.P. 12-4-33 32 weeks preg.

Obstetric History. 7 normal full time deliveries. Well during pregnancies.

Present pregnancy. Well till 18-11-33 when sickness began and persisted until admission. Upper abdominal pain and pain in back. Slight cough.

Examination. Colour good, skin dry, tenderness in right lumbar region, B.P. 120/90.

25-11-33. Sickness less, tenderness in right kidney region, slight dysuria, drowsy, stools offensive.

26-11-33. Very drowsy and confused, jaundiced, abdomen distended, stools pale and offensive.

27-11-33. Spontaneous delivery, child 4½ lbs., stillborn.

28-11-33. Slightly better.

30-11-33. Died.

Bacteriology.

24-11-33. Urine - a few pus cells and coliform organisms.

27-11-33. " abundant pus and coliform organisms, also blood and bile.

25, 28, 30-11-33. Blood culture - growth of coliform organisms.

Post mortem examination. Coliform organisms were isolated from right kidney, uterus, faeces, spleen, lung and the heart blood.

Patient's serum agglutinated organisms from all sources except the faeces, to a titre of 1/12,000.

Name Mrs A.

Age 26

Weight _____

Physician _____

Quarrel _____

Regen _____

Date of Admission

18.11.33

Diagnosis _____

Temp _____

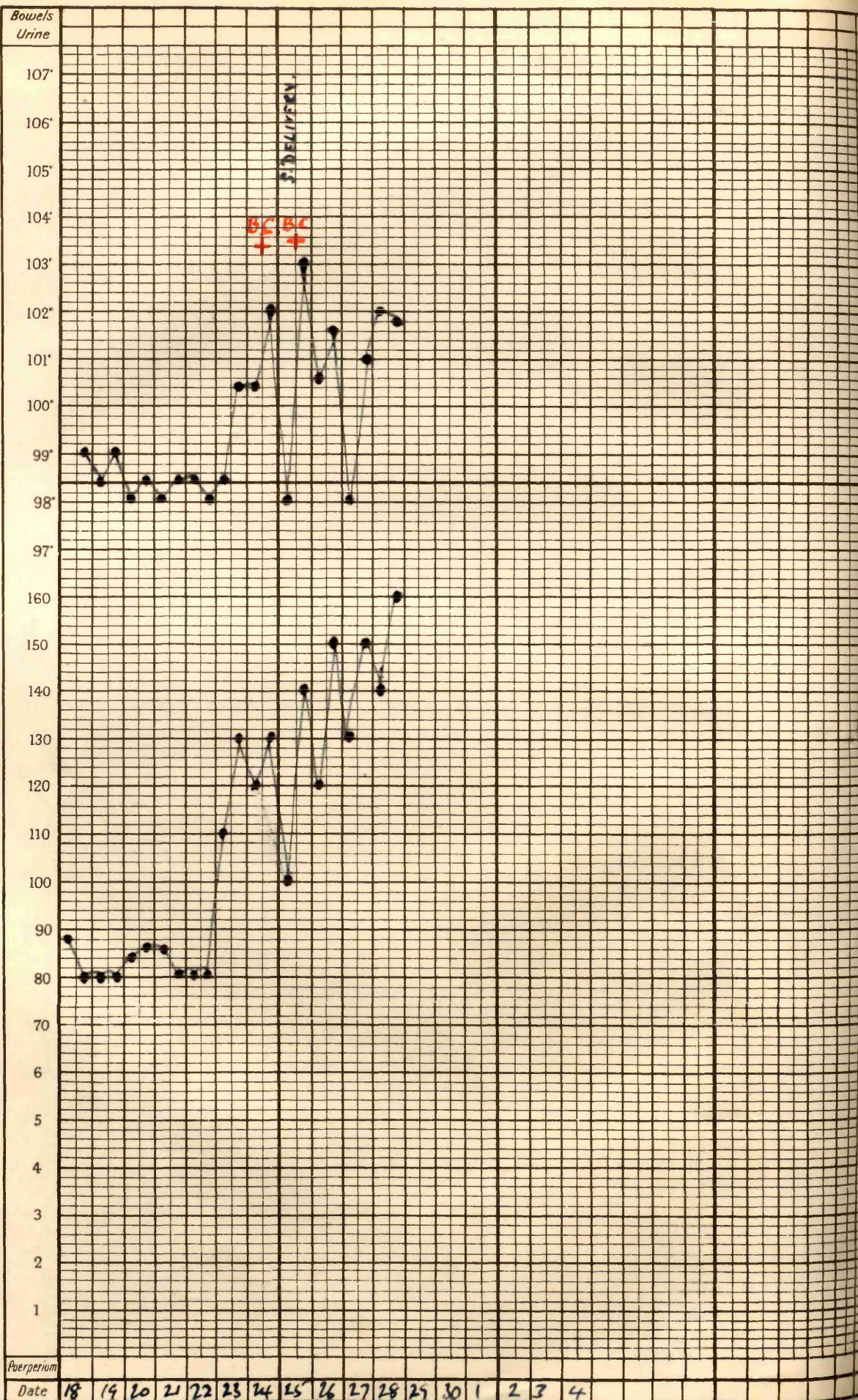
Pulse _____

Fundus _____

and/or

Albumen _____

Case no. 17



Case sheet no.17. Mrs.A. aet.26 3rd pregnancy
 18-11-33. Admitted. L.P.1-3-33. 38 weeks preg.

Obstetric History. 2 abortions at 3 months.

Present pregnancy. Well until the 7th month,when she had an acute attack of pyelitis. Renal symptoms disappeared but vomiting persisted.

Examination. Anaemia, loss of weight, tenderness in right kidney region,slight jaundice,redness of throat. Afebrile.

24-11-33. Rigor,pain in left kidney region.

25-11-33. Spontaneous delivery. Child 6½lbs alive.

26-11-33. Jaundice.

27-11-33. Hiccough and haematemesis. Marked haematuria.

28-11-33. Died.

Bacteriology.

18-11-33. Urine - abundant pus cells and coliform organisms - haze of albumen.

27-11-33. " abundant blood.

24,25-11-33. Blood culture -growth of coliform organisms.

Post mortem examination.

Myocardium shows cloudy swelling and subepicardial haemorrhages.

Small quantity of bile-stained fluid in the peritoneal cavity.

Liver - 73 ozs. - shows advanced cloudy swelling with a few areas of fatty degeneration. Gall bladder normal.

Right kidney - 13 ozs.

Left " 5 "

Right kidney enveloped in a mass of chronically inflamed fatty tissue and on section there is widespread pyelonephritis. Kidney pelvis and ureter are filled with septic blood clot.

Left kidney shows a wedgeshaped area of recent pyelonephritis.

Bladder wall shows a few petechial haemorrhages.

Fig. 103 is a photograph of both kidneys.

Name Mrs D.

Age 21

Ward _____

Physician _____

Journal _____

Page _____

Date of Admission

27.12.30

Diagnosis _____

Temp. _____

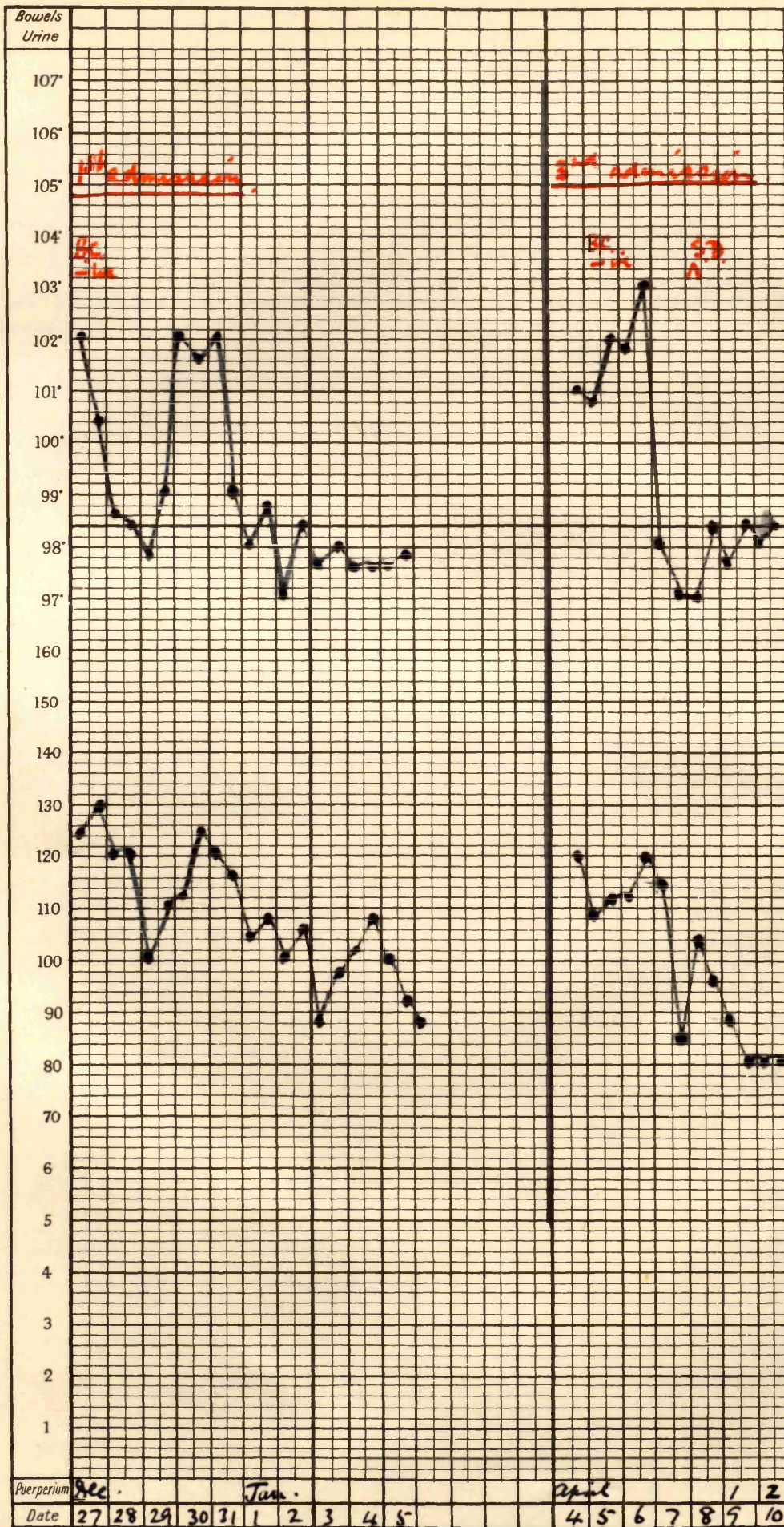
Case no 18.

Pulse _____

Fundus _____

and/or

Albumen _____



Case sheet no.18. 19.
Mrs.D. aet.21 1st pregnancy.

27-12-30. Admitted. L.P. 18-7-30 23 weeks.

Past history. Mitral stenosis for 4 years.

Present pregnancy. Well until 2 days before admission, when sudden attack of acute pain in right kidney region, repeated rigors and severe headache. No bladder symptoms.

Examination. Colour good, flushed, jaundice, tongue coated, no loss of weight, chronic constipation.

2-1-31. Feels well, no sickness, no pain or tenderness complained of.

10-1-31. Dismissed well.

24-1-31. No appetite, complains of occasional pain over the right kidney but no tenderness.

17-2-31. (30 weeks pregnant) nausea and lack of appetite, slight jaundice, intermittent right sided pain, no tenderness.

21-2-31. Readmitted.

27-2-31. Temperature has been normal and pulse 80-100 since admission. Feels well. Dismissed.

14-3-31. Feels well, no sickness.

21-3-31. Severe left sided pain, with shivering attacks and high temperature.

4-4-31. (37 weeks pregnant) Readmitted. Temp. 101°, pulse 120., looks ill, extreme tenderness along course of left urinary tract

7-4-31. Labour commenced spontaneously.

8-4-31. Spontaneous delivery.

14-4-31. 6th day p.p., feels well, anaemia.

13-6-31. 2 mths.p.p., general debility but condition improved.

4-1-33. 1 year and 9 mths.p.p., has not been well since the pregnancy, pain in the back and left side. Severe cardiac condition is probably the cause of the illhealth, as there is no stasis in either urinary tract, and the urine is sterile.

Nov. 1933. Died in Glasgow Royal Infirmary of subacute bacterial endocarditis.

Fig. 106. is a photograph of the kidneys, showing multiple scars in both. The right kidney is much more affected than the left and is much diminished in size. Histological examination confirmed the diagnosis of chronic pyelonephritis.

Bacteriological and Urological Investigation.

27-12-30. Blood culture sterile.

29-12-30. Urine- alb., abundant pus cells and coliform organisms, nonhaemolytic, lactose fermenting, not agglutinated by patient's serum.

7-1-31. Cystoscopic examination. Slight injection of bladder.

I.C. left side 5 mins., good conc.

right " no dye in 15 mins., catheter passed above pelvic brim and dye in very poor conc. tapped. Conc. did not improve on drainage, indicating damage to kidney substance.

Urea concentration of bladder urine is 0.5%.
" " " rt. kidney " " 0.187%

24-1-31. Alb., abundant pus cells and coliform organisms in urine.

27-2-31. " " " " " " " " " "

Intravenous pyelography. Left ureter slightly dilated above the pelvic brim, but the tract otherwise normal. On the right side only a very faint shadow shows in any plate, fig. 112, which indicates extensive damage to kidney function, with only moderate stasis in the ureter.

5-4-31. Blood culture sterile.

13-6-31. 2 mths.p.p. Urine alb+, abundant pus and coliform organisms
Cystoscopic examination. Very slight cystitis, bladder capacity normal.

I.C. left side 5 mins., good conc.

right " 6 " fair "

4-1-33. 1 year and 9 mths.p.p. Urine sterile.

Cystoscopic examination. Bladder normal.

I.C. left side 5 mins. good conc.

right " " " " "

Catheter passed into left ureter and 10 ccs of acriflavine injected caused pain, which did not resemble the pain complained of.

Ill health is therefore probably due to the cardiac condition.

Name Mrs W.

Age 18

Ward

Physician

Journal

Page

Date of Admission

9.1.30

Diagnosis

Temp.

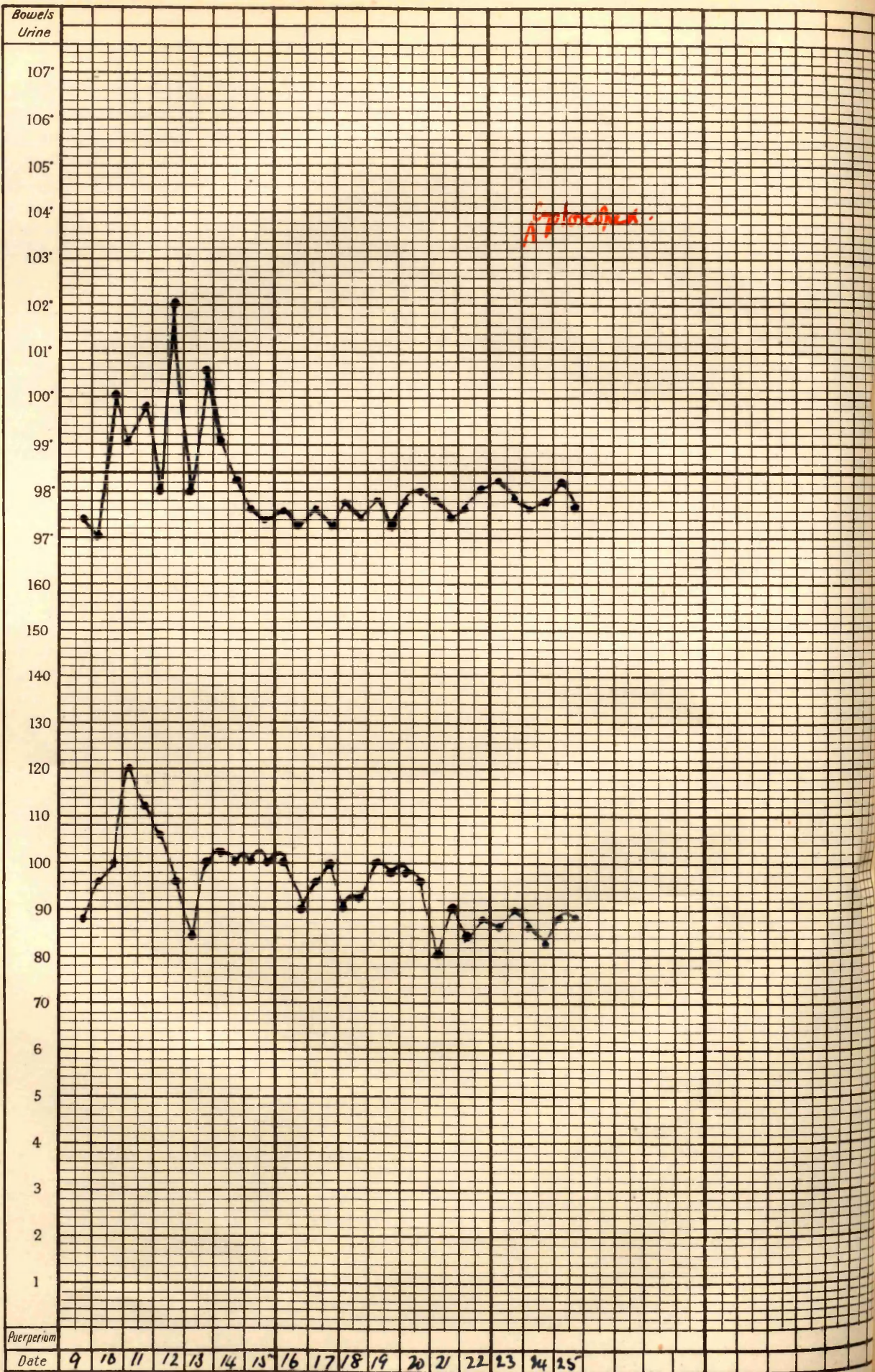
Case no. 19.

Pulse

Fundus

and/or

Albumen



Case sheet no 19. Mrs W. aet 18 1st pregnancy.
 9-1-30. Admitted. L.P. 16-7-29. 25 weeks pregnant

Present pregnancy. Well till 3 days before admission when she had sudden severe pain in the back, with pain and frequency of micturition.

Examination. No anaemia, jaundice or oedema. Tongue moist.
 Tenderness over both kidneys especially the right.
 15-1-30/ Temperature settled.
 8-2-30. Dismissed improved.
 1-3-30. Feels well but slight right sided tenderness.
 22-3-30. Oedema of the legs marked.
 29-3-30. Readmitted. Headaches severe. Esbach 2-3 parts. A few pus cells but no organisms in the urine.
 5-5-30. Esbach still 2 parts. B.P. 155/110.
 6-5-30. Spontaneous delivery. Child alive, 5½ lbs.
 18-5-30. Dismissed well.
 15-6-30. Feels weak. Marked swelling of the feet.
 9-8-30. Still not well. Severe headache and oedema.

Bacteriological and Urological Examination.

10-1-30. Urine contains abundant albumen, blood, pus and coliform organisms, no casts. Haemoglobinuria.
 24-1-30. Cystoscopic examination.
 L. kidney urine contains red blood corpuscles and a few coliform organisms.
 R. kidney urine contains red blood corpuscles and a few coliform organisms.
 Bladder urine contains abundant blood and numerous pus cells and coliform organisms.
 31-1-30. I.C. left side 9 minutes.
 right " 19 " poor conc. at both sides.
 31-3-30. Urine. albumen ++, R.B.C. +++, a few pus cells and coliform bacilli.
 17-5-30. 11th day p.p. I.C. left side 15 mins.
 right " 10 " poor conc. at both.
 15-6-30. I.C. left side 8 mins.
 right " " " poor conc. at both sides.
 Bladder urine contains albumen ++ but no pus cells or organisms.
 A retrograde pyelogram shows slight clubbing of calyces on the right side.

May 1931.

2nd pregnancy.

Pregnancy terminated in the 9th month because of albuminuria.

3rd pregnancy.

August, 1933.

Eclampsia at 5th month. Abdominal hysterotomy and sterilisation.
 Urine contained abundant albumen, pus cells and coliform organisms.

Name Mrs H.

Age 20

Wards _____

Physician _____

Journal _____

Page _____

Date of Admission

25-11-32

Diagnosis _____

Temp. _____

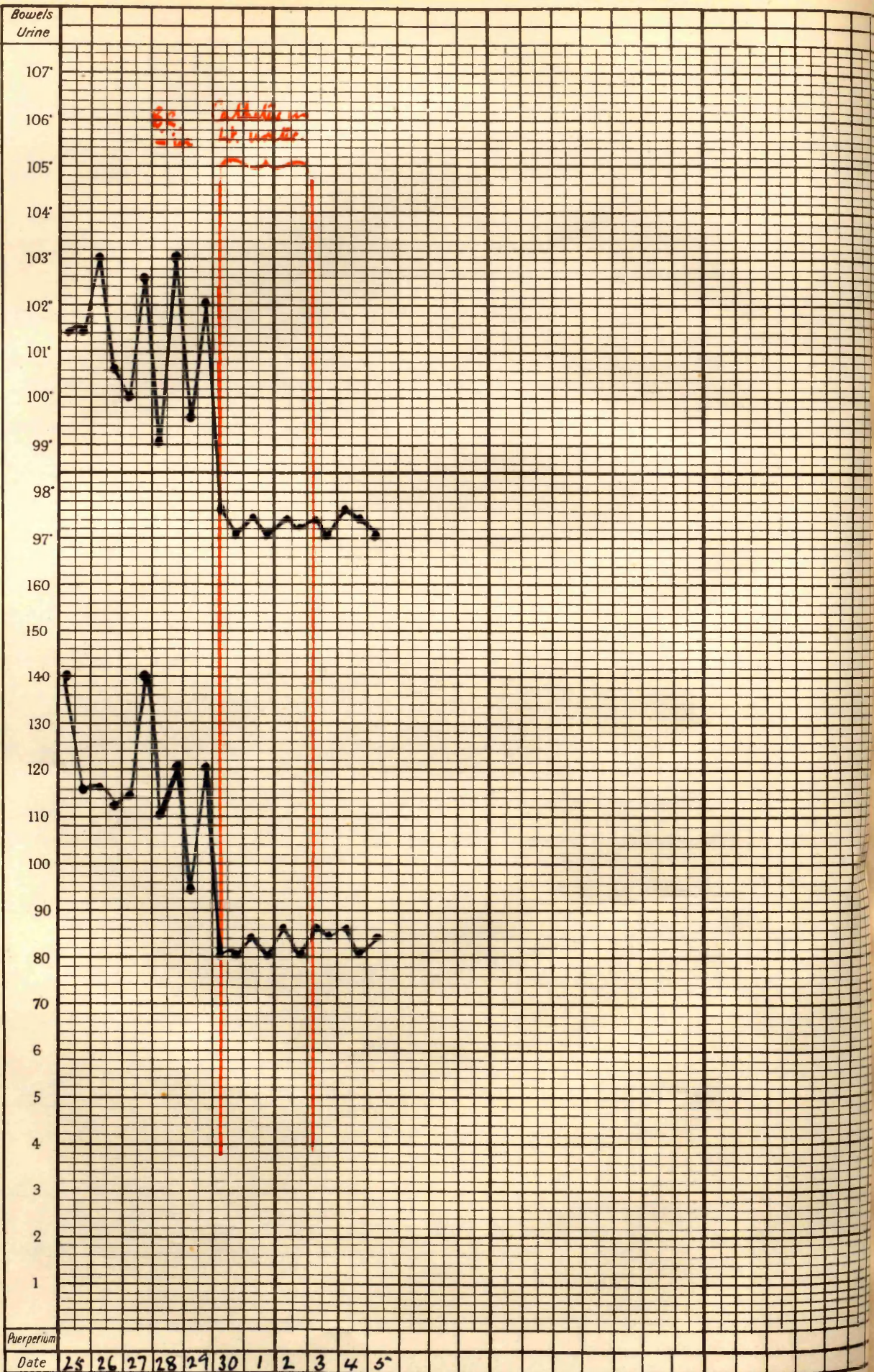
Case no. 20.

Pulse _____

Fundus _____

and/or

Albumen _____



Case sheet no.20. Mrs H. aet.20. 1st pregnancy.
 25-11-32. Admitted. L.P.21-6-32. 23 weeks preg.

Present pregnancy. The night before admission rigor and pain in left side. Vomiting.

Examination. Marked anaemia, loss of appetite and oedema.
 Respirations rapid, Temp. 103°, pulse rate 140.
 Dullness at the left base. Tenderness over whole of left side of abdomen and chest, worse in the costo-vertebral angle. Widespread hyperaesthesia in the same area.

- 30-11-32. Tenderness very acute until today, when a catheter was inserted into the left ureter.
 1-12-32. Still no tenderness. Breath sounds still impaired.
 5-12-32. Still dullness at the left base.
 11-12-32. Dismissed.
 1-2-33. Readmitted with sudden onset of severe left sided pain, similar to first attack.
 14-2-33. Dismissed. Pain and tenderness disappeared very quickly.

Bacteriological and Urological Examination.

- 27-11-32. Blood culture sterile.
 Urine abundant blood and casts, no organisms. Culture -ve.
 No tubercle bacilli found in 24 hour specimen of urine.
 30-11-32. Sputum gives abundant growth of pneumococci.
Cystoscopic examination. No I.C. in 13 mins. at either side. Catheters passed and on left side within a few mins. the hyperaesthesia, pain and tenderness disappeared.
 Catheter left in position for 3 days and then removed.
 14-1-33. Urine contains albumen +, numerous pus cells and coliform organisms.

In this case, as explained in the text, the pain was probably due to obstruction at the left ureteropelvic junction, secondary to the inflammatory congestion of the base of the left lung.

Name Mrs. H. K.

Age 20

Ward _____

Physician _____

Journal _____

Regen _____

Date of Admission

14.11.31

Diagnosis _____

Temp. _____

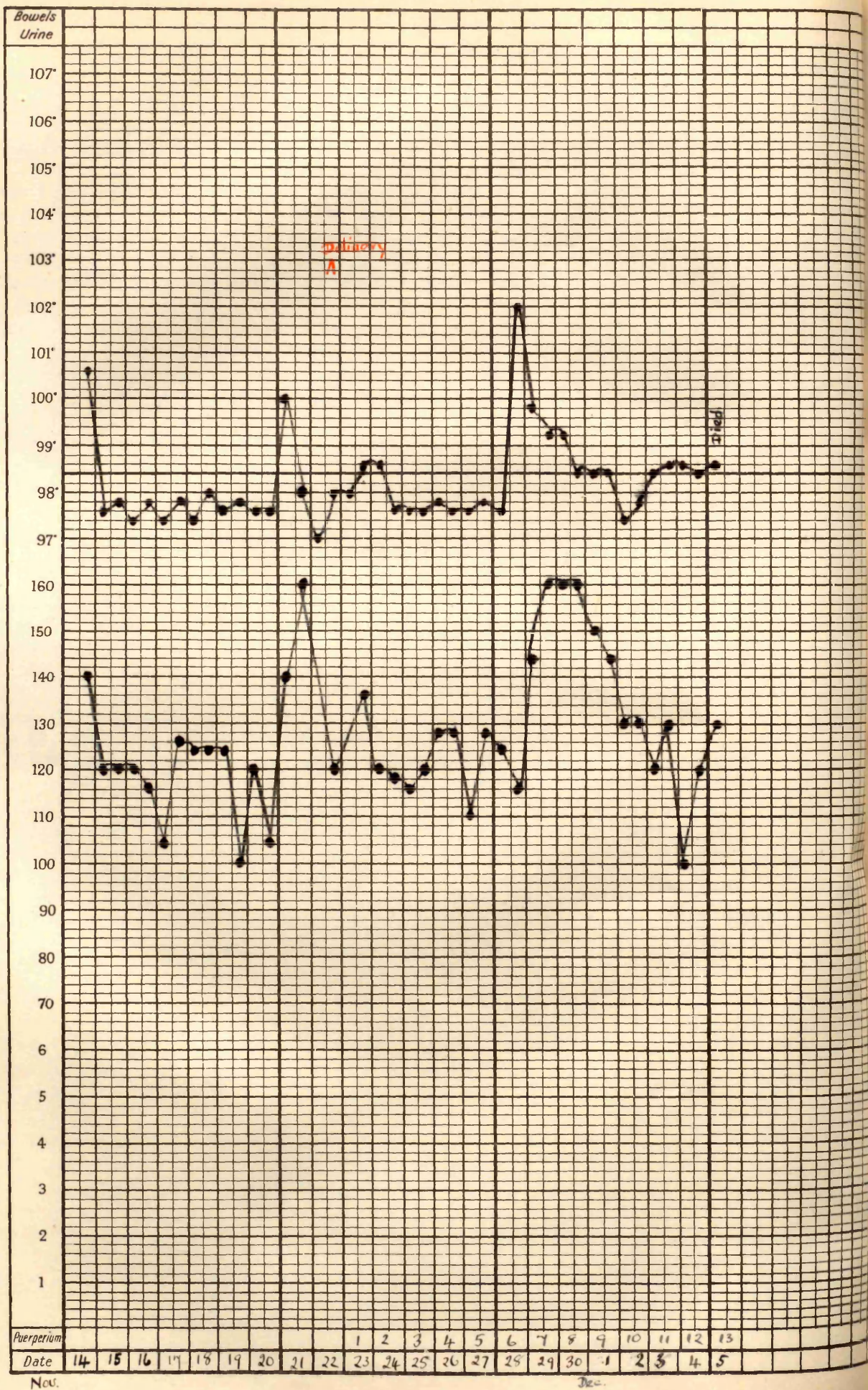
Case no. 21.

Pulse _____

Fundus _____

and/or

Albumen _____



Case sheet no.21. Mrs McK. aet.20 1st pregnancy.

14-11-31. Admitted. L.P. 17-4-31. 30 weeks.

Present pregnancy. Ill for 2 months before admission with right sided pyelitis.

Examination. Anaemia, emaciation, no jaundice, slight vomiting, tenderness over right kidney. Afebrile, pulse rate 120.

22-11-31. Condition steadily worse. Jaundice, lack of appetite, loss of weight. Afebrile but pulse rate 110-130.

Labour induced, child alive 3 $\frac{3}{4}$ lbs.

3-12-31. 11th day postpartum died. Following delivery although the urinary output was good she became more jaundiced and more emaciated: Nystagmus and squint developed and she became semicomatose. Coma gradually deepened until death.

Post mortem findings. Massive collapse of greater part of upper lobe of left lung. 16 ozs. of turbid fluid in left pleural cavity.

Liver weighed 56 ozs. Cloudy swelling.

Right kidney was enlarged and contained multiple abscesses and right ureter was moderately dilated.

Left kidney and urinary tract normal.

14-11-31. Urine contained albumen +, pus cells and coliform organisms.

Death in this case was due to pyelonephritis and septic pneumonia, spread from the kidney following delivery.

Case sheet no.22. Mrs.McF. aet.35 3rd pregnancy

22-3-30. Admitted. L.P. 20-12-29. 13 weeks preg.

Obstetric history. 2 normal full time pregnancies.

Present pregnancy. Vomiting and loss of weight since beginning of pregnancy. Right sided pain.

Examination. Afebrile, pulse rate 90. Anaemia and loss of weight. Tongue coated. Abdomen somewhat distended. Tenderness over both kidneys. Drowsy.

25-3-30. Temperature has been 99° and pulse rate between 110 and 130 since admission.

26-3-30. Spontaneous abortion.

20-4-30. Progress unsatisfactory, emaciation and vomiting. Temp. normal but pulse rate varies between 100 and 120.

2-5-30. Died.

Bacteriology.

26-3-30. Albumen + , numerous pus cells and coliform organisms, all lactose fermenters, of the same type.
Sugar reactions - +++-AC-+.

Permission for postmortem examination was refused so that the diagnosis of bilateral pyelonephritis could not be confirmed.

Case no. 23.

Case sheet no.23. Mrs.C. aet.33 1st pregnancy.
 10-3-31. Admitted. L.P.13-9-30. 25 weeks preg.

Present pregnancy. 6 weeks before admission sudden attack of severe pain in the right side. Great frequency and pain on micturition. Confined to bed since then. Occasionally pain on left side. For 3 weeks before admission almost continuous sickness. Became very emaciated.

Examination. Anaemia, jaundice and emaciation. Tongue dry and coated. Slight tenderness along the right urinary tract. B.P. 118/70.

- 19-3-31. Since admission temperature 99° - 100°, pulse rate 120 and urinary output small. Frequent vomiting. Ureteral drainage.
 21-3-31. Catheters removed. During the time they were in position they drained very satisfactorily and patient felt better. Temperature and pulse rate fell.
 22-3-31. Abdominal hysterotomy performed.
 24-3-31. Condition worse following operation and died.

Bacteriological and Urological Investigation.

- 11-3-31. Albumen +- , abundant pus cells and coliform organisms in urine.
 19-3-31. Cystoscopic examination. No cystitis. No I.C. in 15 mins. at either orifice. Catheters passed into both ureters. No I.C. through either catheter in 15 mins. Urine drained from each catheter at the rate of 1 oz an hour.

This is an example of a neglected case of bilateral pyelonephritis, with extensive damage to both kidneys.

Case sheet no.24. Mrs.D. aet 27 7th pregnancy
 18-8-31. Admitted. L.P. Feb.1931. About 26 wks.

Obstetric history. 1st and 2nd normal full time pregnancies.
 3rd ChCl₃ and instruments, stillborn.
 4th " " " " alive.
 5th miscarriage at 4½ months.
 6th normal full time pregnancy.

Present pregnancy. For 12 weeks before admission complaining of attacks of severe right sided pain, very much worse on the day of admission.

Examination. Temp. 101°, pulse rate 120. Abdomen distended and tense with tenderness all over, especially in the right kidney region.

19-8-31. Condition unchanged. Vomiting frequently.
Cystoscopic examination. A catheter was obstructed at the level of the pelvic brim in the right ureter. No urine drained from the right side. I.C. left side normal.

20-8-31. Complete miscarriage occurred spontaneously, after which patient collapsed and died 4 hours later.

Bacteriology.

18-8-31. Urine contains a haze of albumen, a few pus cells and coliform bacilli.

Postmortem Findings. Death was found to be due to peritonitis, of coliform origin, due to rupture of the ureter by an impacted calculus at the level of the pelvic brim on the right side. The right kidney was the seat of an advanced pyelonephritis.

Case sheet no.25. 27.
Mrs C. aet 37 1st pregnancy.

30-12-30. Admitted. L.P. 26-4-30. 35 weeks pregnant.

Present pregnancy. Admitted because of breech presentation and contracted pelvis. Well through out pregnancy.

15-1-31. Sudden rigor and high temperature and pulse rate.
Blood culture was +ve. Pain over both kidney regions.

17-1-31. Caesarean section performed. Child 9 lbs. alive.
Temperature remained elevated and patient became gradually weaker. Vaccines, urinary antiseptics and intravenous antiseptics were given without success.

16-2-31. Discharge of pus from the abdominal scar.

17-2-31. Died.

Bacteriology.

30-12-30. Urine sterile.

16-1-31. Blood culture - growth of coliform organisms.
Urine now contains abundant pus cells and coliform organisms.

Sugar reactions of the coliform organisms, -

Urine +++++AC++

Blood +++++AC++

The same organism was isolated from the vagina.

Postmortem findings. Emaciated and abdominal wound healed except for sinus at lower end.

Lungs. Consolidation at both bases.

Liver .Pale and fatty. Empyema of the gall bladder, with rupture into the peritoneal cavity. Pus fairly well sealed off by adhesions. 3 small calculi in the cystic duct.

Kidneys. Dilatation of both ureters and multiple small abscesses in kidneys.

Uterine wound sloughing and badly healed.

Case sheet no.26. Mrs.D. aet.24 4th pregnancy.

22-2-30. Admitted. L.P. 28-7-29. 30 weeks pregnant.

Obstetric history. 1st normal full time pregnancy.
2nd and 3rd miscarriages at 3 months.

Present pregnancy. Sudden onset 1 month before admission with
right sided pain and vomiting.

Examination. Anaemia, wasting, sickness, lack of appetite, tenderness
in both kidney regions. Temp. normal, pulse rate 100-110.

2-4-30. Dismissed much improved.

Bacteriological and Urological examination.

23-2-30. Urine contains no albumen, abundant pus cells and coliform
organisms, haemolytic and lactose fermenting.

Patient's serum agglutinated the organisms found in the
urine up to 1/50.

Sugar reactions were +++++AC++

26-2-30. Cystoscopic examination. No cystitis.

I.C. left side 4 mins. good conc.

right " none in 20 mins.

Catheters passed into both ureters.

Urine from right kidney heavily infected with pus and coli.

" " left " contains a few pus cells and coli.

6-3-30. Maclean's Urea test. Bladder urine before urea - 0.875%.

" " at 1 hour - 1.82%.

Urine from R. kidney at 1 1/4 hours - 1.29%.

" " " " " 1 1/2 " - 0.93%.

" " L. " " 1 1/4 " - 3.57%.

" " " " " 1 1/2 " - 3.69%.

2-5-30. Readmitted in labour.

Spontaneous delivery, 6lbs.

19-5-30. Died of ? pyaemia.

Postmortem examination refused.

Name Wm R
 Age _____
~~Ward~~ _____
 Physician _____
~~Location~~ _____
~~Room~~ _____
 Date of Admission _____

 Diagnosis _____
 Temp. _____

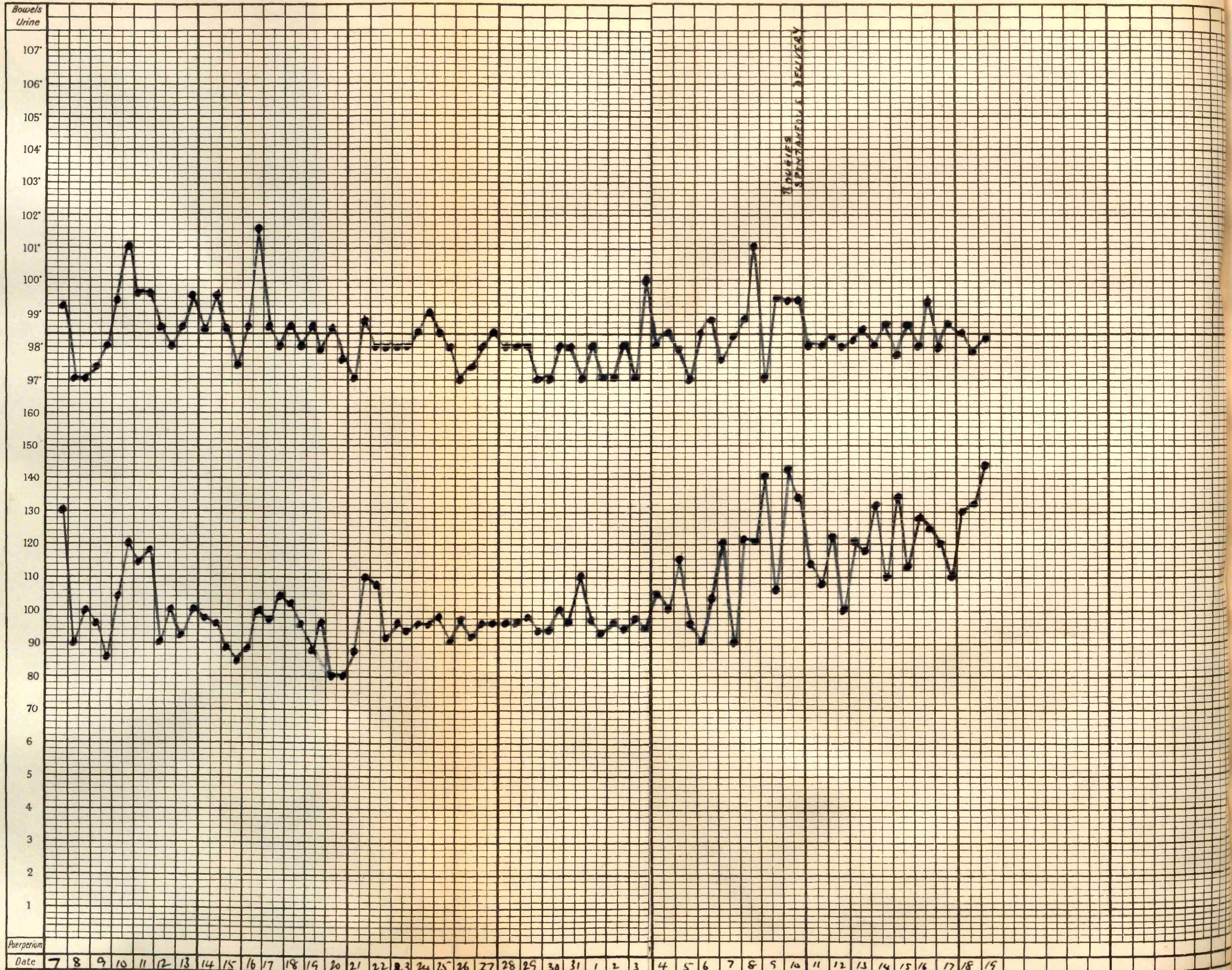
Case no 27

Pulse _____

Fundus _____

and/or

Albumen _____



Oct

November.

Case sheet no.27. Mrs.R. aet 25 3rd pregnancy
 8-10-30. Admitted. L.P. 30-5-34 19 weeks pregnant.

Obstetric History. Well during the first pregnancy, which ent to full time. Spontaneous delivery.

2nd. Severe vomiting for last 3 months, probably due to pyelitis. Spontaneous delivery, child small.

Present pregnancy. For 3 weeks before admission right sided pain and shivering attacks, frequency of micturition.

Examination. Anaemia, loss of weight, slight jaundice, Temp. 99, pulse rate 120.

14-10-30. Temp. to 99, pulse rate 100-120.

2-11-30. Temp. has been normal for 14 days and pulse rate 90-100, but patient is very listless and is losing weight.

3-11-30. Cystoscopic examination. Bladder so injected and sensitive that satisfactory urological examination could not be made.

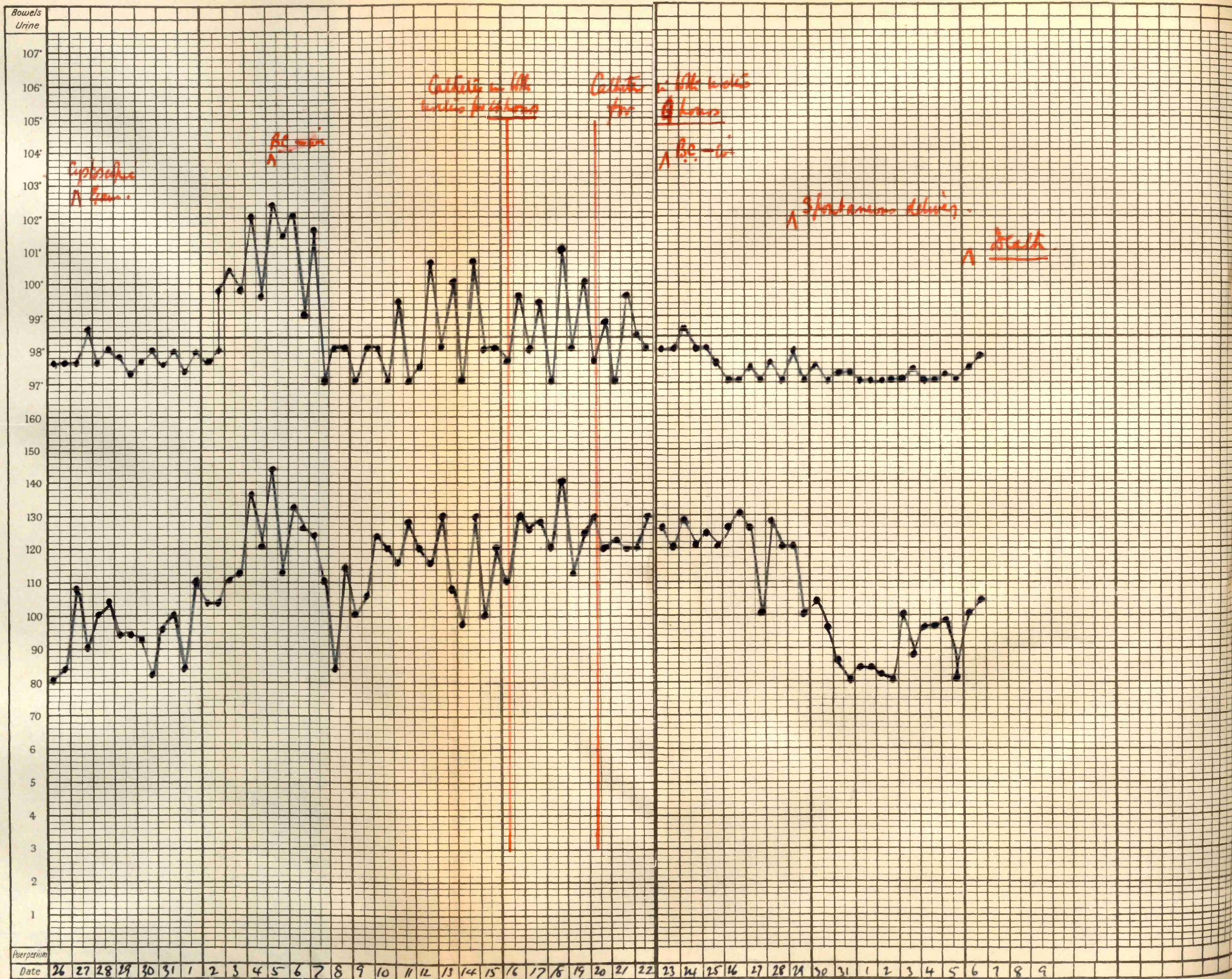
10-11-30. Pulse rate has risen steadily to 140. Bougies inserted for induction of labour. Spontaneous delivery.

19-11-30. Died. Pulse rate gradually rose following delivery and patient became more and more drowsy.

Post-mortem findings. Hypostatic congestion at the base of both lungs.

Heart and liver normal.

Both kidneys each weigh 6 ozs., and contain multiple abscesses. Moderate dilatation of both kidney pelves and ureters.



Case sheet no.28.

Mrs.H.

aet.21

1st pregnancy

26-12-29. Admitted.

L.P. End of July, 1929.

21 weeks.

Present pregnancy. Well till 3 weeks before admission, when she had severe pain in the back with rigors, pain and frequency of micturition.

Examination. Temperature normal, pulse rate 100. No anaemia or jaundice or abdominal tenderness.

- 1-1-30. Pain severe again on both sides, sickness and vomiting.
Dysuria. Temp. 102°, very rapid pulse.
5-1-30. Very tender over right kidney, losing weight rapidly.
16-1-30. General condition deteriorating. Catheters inserted into both ureters but withdrawn after a few hours as they did not drain well.
20-1-30. Catheters again inserted. Urine from both kidneys relatively clear. Catheters removed in 9 hours.
22-1-30. Vomiting persistent. Jaundice. No renal tenderness:
23-1-30. 18 ccs of 1% mercurochrome injected intravenously. No obvious effect.
27-1-30. Feels better.
28-1-30. Mercurochrome repeated.
29-1-30. Esbach U+. Urinary output 2 ozs. in 24 hours.
Bougies inserted and delivery completed in a few hours.
6-2-30. Died. She looked better for 2 days postpartum but very little urine was passed, and she became gradually weaker.

Bacteriological and Urological Examination.

- 27-12-29. Urine contains albumen +, numerous pus cells and coliform organisms, haemolytic and lactose fermenting.
Sugar reactions are +++-A-+
Cystoscopic examination. Catheters passed. Urine from both kidneys infected.
5-1-30. Blood culture sterile.
11-1-30. Urea concentration test, highest concentration 1.49%.
16-1-30. Cystoscopic examination. No cystitis. Catheters passed and left in situ for 9 hours, without benefit.
20-1-30. Catheters again passed without benefit.
Urine from both kidneys are heavily infected.
23-1-30. Blood culture sterile.

Post mortem Findings.

Lungs. Left sided hypostatic pneumonia.
Signs of generalised septicaemia.
Recent vegetations on mitral valve.
Both kidneys contain multiple abscesses.
Coliform organisms were cultured from the heart blood and spleen.
Ureters only moderately dilated, each held 20 ccs.

Name Mrs D.

Age 21

Ward _____

Physician _____

Journal _____

Page _____

Date of Admission
6-1-31

Diagnosis _____

Temp. _____

Case no. 29.

Pulse _____

Fundus _____

and/or

Albumen _____



Case sheet no.29.

Mrs.D.

aet. 21.

1st pregnancy

6-1-31. Admitted.

L.P. 20-6-30.

28 weeks pregnant.

Present pregnancy. 4 weeks before admission took ill with severe right sided pain and bladder symptoms, headaches, vomiting and rigors.

Examination. Slightly anaemic, slightly jaundiced. Tongue coated. Very tender along right urinary tract. No oedema.

- 14-1-31. High temperature and rapid pulse since admission. Today uterine contractions. Cervix 3 fingers dilated, with membranes bulging.
Catheter inserted into right ureter and renal tenderness and uterine contractions disappeared at once. The temp. and pulse rate fell.
- 15-1-31. Catheter removed.
- 17-1-31. Feels well. Temperature normal. No tenderness.
- 19-1-31. Temperature again elevated and tenderness over right kidney severe. Uterine contractions again begun.
Membranes ruptured and cervix still 3 fingers dilated.
- 21-1-31. Delivered.
Convalescence very satisfactory.
- 31-1-31. Dismissed.

Bacteriological and Urological Examination.

- 7-1-31. Albumen + , numerous pus cells and coliform organisms in the urine.
- 14-1-31. Congestion of the bladder mucosa, no I.C. at either side in 9 minutes. Catheter passed into right ureter. No I.C. tapped at first but it appeared soon in good conc.
Right ureter appears to be only moderately dilated.
Catheter left in for 12 hours.
Urine from right kidney contains numerous pus cells and coliform organisms, which were not agglutinated by the patient's serum.
- 30-1-31. Urea concentration test reached 2.12% in the 3rd hour.
- 28-2-31. 6 weeks postpartum, the urine contains no albumen, a few pus cells and coliform bacilli.

This case shows the close correlation between uterine and ureteric contractions. The chart shows the dramatic fall in temperature and pulse rate which followed ureteral drainage for only a few hours.

Name Mrs K

Age 32

Weight _____

Physician _____

Journal _____

Pages _____

Date of Admission

30.7.32

Diagnosis _____

Temp _____

Case no. 30

Pulse _____

Fundus _____

and/or

Albumen _____



Case sheet no.30. Mrs.K. aet.32 1st pregnancy.

30-7-32. Admitted. L.P. 15-3-32. 20 weeks pregnant

Present pregnancy. Severe right sided pain 2 weeks before admission. Fevered, vomiting and headache, since then.

Examination. No anaemia, oedema or loss of weight. B.P.120/70. No tenderness in either kidney region. Temp.100°, pulse rate 110.

7-8-32. Fluid withheld for 12 hours before intravenous pyelography. This was followed by a rise of temperature to 102° and of pulse rate to 120. These settled quickly.

12-8-32. Fluid withheld for 8 hours, before a urea concentration test and pyrexia again occurred.

1-8-32. Urine contains albumen +-, abundant pus cells and organisms (coliform).

8-8-32. Intravenous pyelogram shows delay in appearance of the calyces on both sides. Moderate dilatation of both urinary tracts. Appearances suggest bilateral infection.

13-8-32. MacLean's urea concentration test - highest reading 1.91% in the 3rd hour after urea. Also suggests bilateral infection.

Name Mrs Y
 Age _____
 Ward _____
 Physician _____
 Journal _____
 Page _____
 Date of Admission 18.1.34
 Diagnosis _____
 Temp. _____

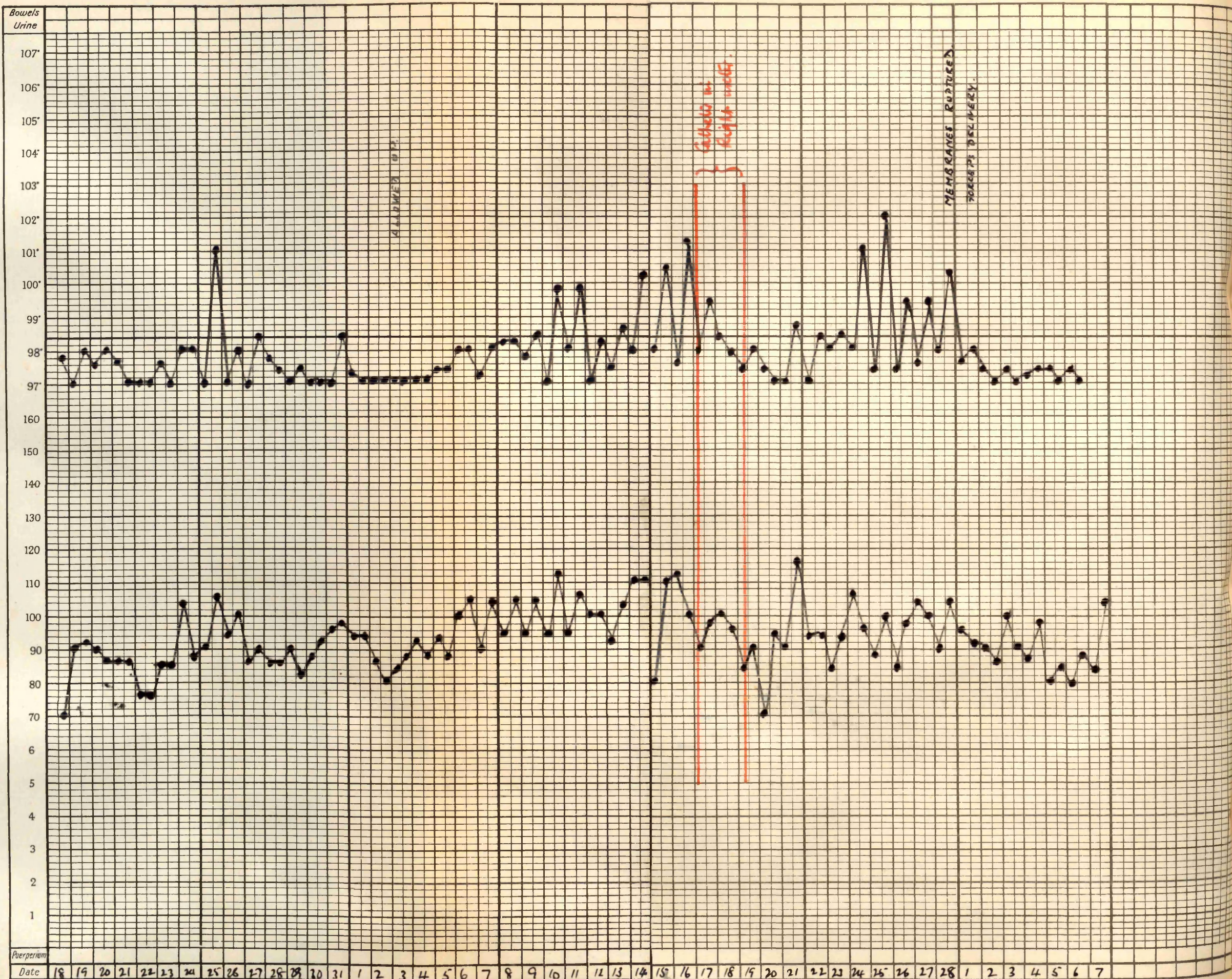
Case no 31

Pulse _____

Fundus _____

and/or

Albumen _____



Case sheet no.31.

Mrs.Y.

aet 27

1st pregnancy

18-1-34. Admitted.

L.P. 28-6-33.

29 weeks pregnant.

Present pregnancy. In 4th month rigor and severe right sided pain.
Several weeks later left sided pain.

Examination. Marked anaemia, skin dry, very emaciated, slight tenderness over both kidneys behind. Afebrile. Pulse rate 90.

24-1-34. Cystoscopic examination. Bladder filled with pus and debris.

I.C. left side 5 mins. fair conc.

right " none in 10 mins.

Catheters passed into both ureters. Very little pus drained on left side. In right ureter catheter tapped I.C.

above brim in very poor conc., which did not improve.

Bladder urine contains abundant pus cells and coliform organisms. Urea conc. 0.87%.

Specimens were collected from both ureters at intervals.

Urine from both kidneys was heavily infected.

	Amount drained	Urea		Amount drained	Urea
1. R.kidney	6.5ccs.	0.63%	L.kidney	9.8ccs.	0.83%
2.	7 ccs	0.56%		11.8ccs	0.83%
3.	6.8ccs	0.54%		12.1ccs	0.87%
4.	3.5ccs	0.52%		7.9ccs	0.94%

25-1-34. Bladder urea conc.

Time	Quantity	Concentration.
Before urea	132ccs	0.57%
1 hour	105	0.75%
2nd "	108	1.31%
3rd "	106	1.34%

1st hour blood urea 9.6 mgms. per 100ccs.

N.P.N.	21	"	"	"
3rd " blood urea	11.2	"	"	"
N.P.N.	30	"	"	"

26-1-34. Patient's weight 105 lbs. Liberal diet ordered, and postural treatment.

1-2-34. Weight now 106 lbs. Condition improving.

3-2-34. Allowed up.

8-2-34. Weight 107 lbs. Feels much stronger.

10-2-34. Slight elevation of temp., pain in back, not so well.

16-2-34. Temp. 101, pulse rate 110, sweating at night. 107 lbs.

17-2-34. Catheter inserted into right ureter for 48 hours.

Temp. settled quickly and pulse rate fell to 90. Felt much better.

25-2-34. Pain in left side of chest. Elevation of temp. and pulse rate. Does not look well.

28-2-34. Membranes ruptured.

1-3-34. Forceps delivery.

7-3-34. Temp. normal since delivery, pulse rate now 80.

11-3-34. Dismissed well, although still very thin. Weight 100 lbs.

Name Wm. H. P.

Age 33

Word

Physician

Journal

Page

Date of Admission

23.7.32.

Diagnosis

Temp.

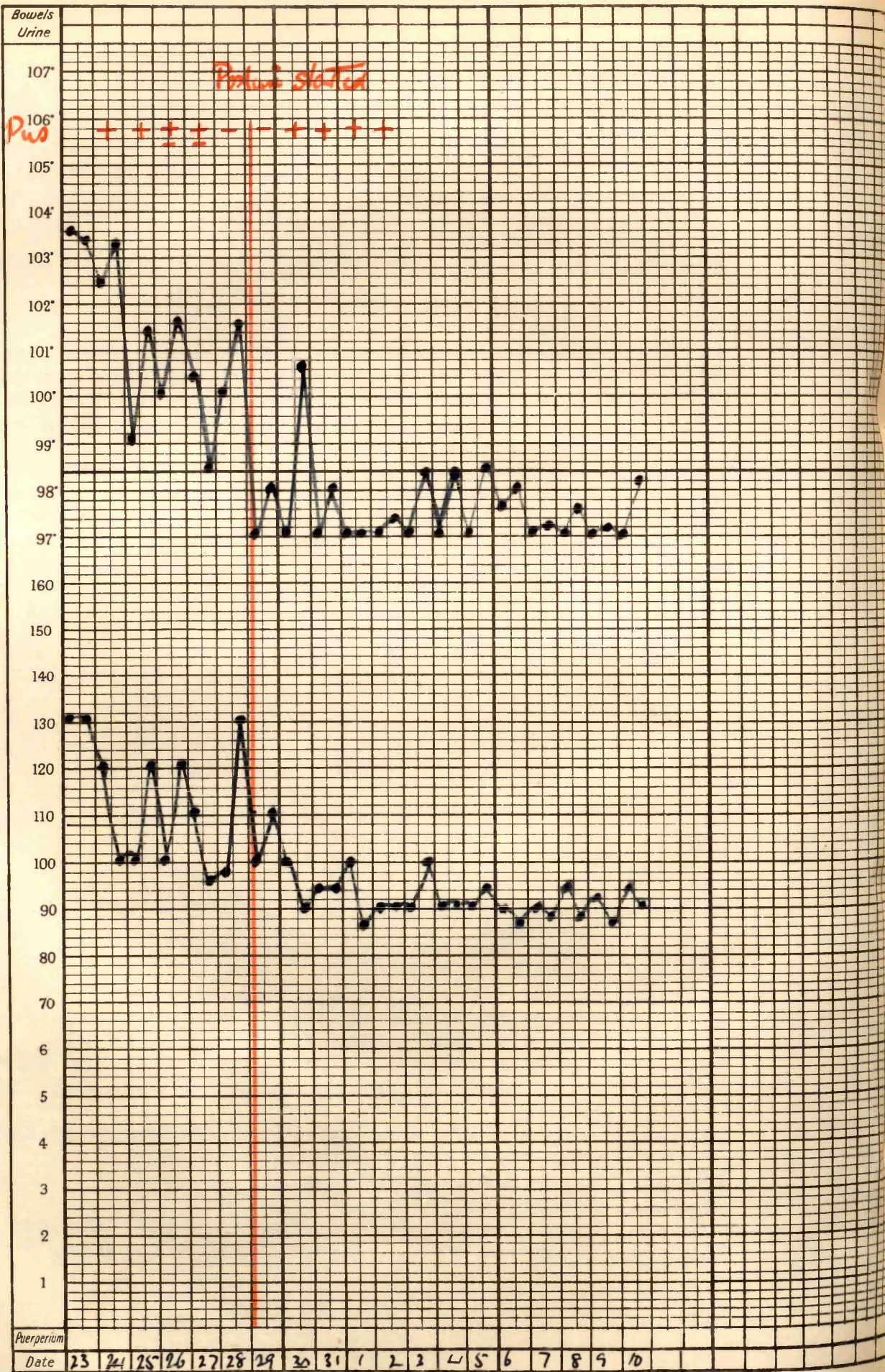
Case no 32.

Pulse

Fundus

and/or

Albumen



Case sheet no.32. Mrs. McL. aet 33 2nd pregnancy

23-7-32. Admitted. L.P. 17-1-32. 27 weeks pregnant.

Obstetric history. 1st normal full time pregnancy, instrumental delivery, followed by puerperal sepsis.

Present pregnancy. Right sided pain for 4 days ,very much worse on day of admission.

Examination. Temp. 103°, pulse rate 130. Very flushed, tongue dry and furred, extreme tenderness over right kidney behind. Condition remained unaltered till

29-7-32. When patient was placed in hands and knees position for 10 minutes every hour. Tenderness disappeared rapidly from the right kidney region, and temp. and pulse rate dropped quickly. The amount of pus in the urine increased, showing the better drainage.

27-4-32. Urine contains albumen +- , abundant pus cells and coliform organisms.

Name Mrs H.

Age 22

Ward _____

Physician _____

Journal _____

Pages _____

Date of Admission

13.10.31

Diagnosis _____

Temp. _____

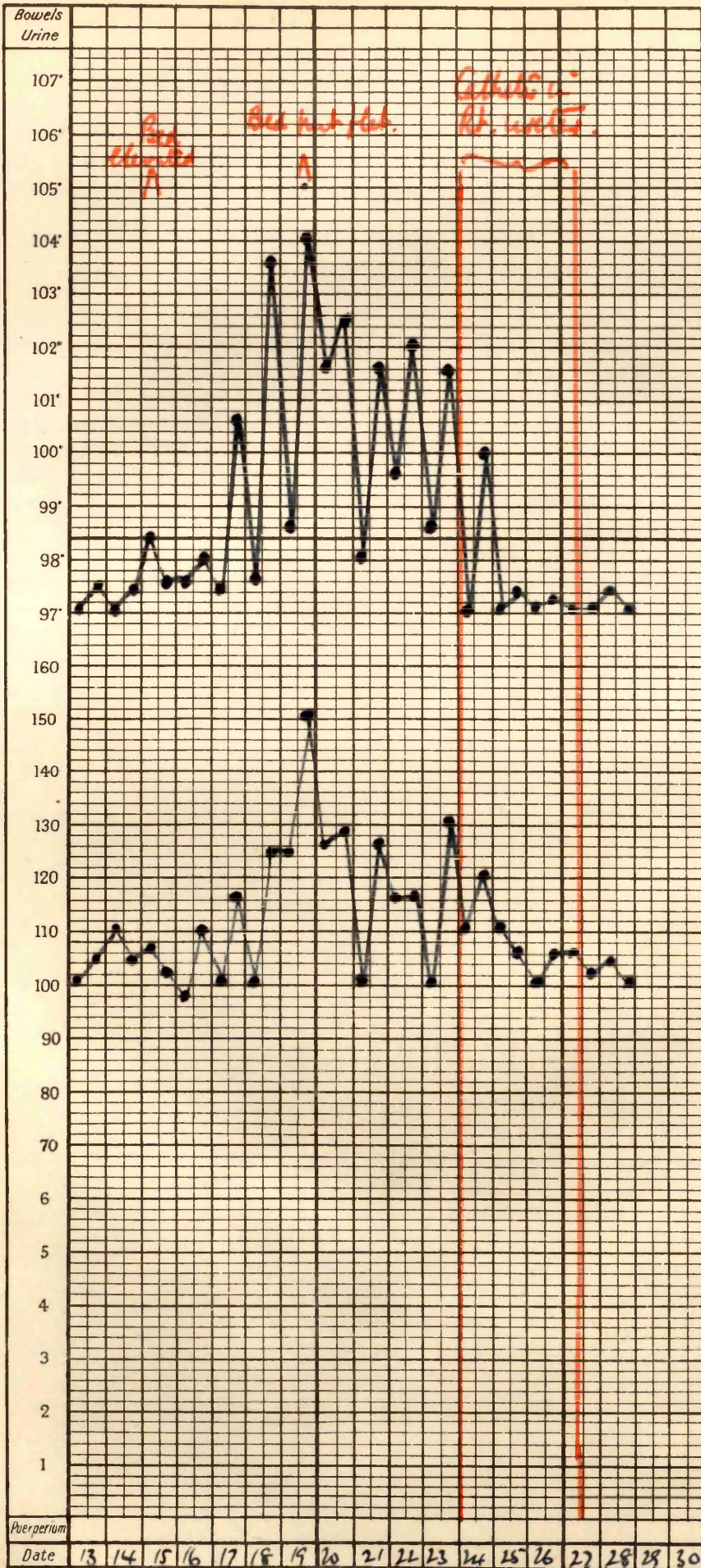
Case no. 33.

Pulse _____

Fundus _____

and/or

Albumen _____



Case sheet no.33. Mrs.H. aet.22. 1st pregnancy.

13-10-31. Admitted. L.P. 24-4-31. 25 weeks.

Present pregnancy. Sickness ,rigors and right sided pain for 1 month. Pain and frequency of micturition for same time.

Examination. Anaemia,wasting and sickness,slight jaundice.
Tenderness along whole of right urinary tract.
Temp.normal,pulse rate 100-110.

15-10-31. Foot of bed elevated.

17-10-31. Temp. and pulse rate elevated.

19-10-31. Temp. 104° and pulse rate 150. Bed put flat.
This was followed by a steady improvement ,which was greatly accelerated by insertion of ureteral catheter on the right side.

8-11-31. Dismissed much improved.

11-12-31. Feels very well,no sickness.

14-1-32. Spontaneous delivery - child alive 6½ lbs.

23-1-32. Dismissed. Puerperium was normal.

Bacteriological and Urological Examination.

24-10-31. Cystoscopic examination. Some cystitis and ureteral orifices patulous. Marked alkaline deposit of phosphates on fundus.

I.C.left side 11 mins.

right " none in 16 mins. Catheter passed to 25 cms.
and drained very well - I.C. in fair conc.

Bladder urine contains albumen +,abundant pus cells and coliform organisms.

Right kidney urine contains albumen + ,abundant pus cells and a few coliform organisms. Catheter left in position.

25-10-31. Patient very much better- no sickness.

27-10-31. Feels very much better. Catheter removed.

8-11-31. I.C. left side 5 mins.

right " 15 " ,marked improvement in elimination.

19-2-32. 1 month p.p. I.C. left side 7 mins.

right " 10 mins. after massage.

Urine contains numerous pus cells and abundant coliform organisms.

In this case the elevation of the foot of the bed undoubtedly caused an exacerbation of the symptoms and recurrence of fever.

Name Mrs. O'M

Age 20

Weight

Physician

Journal

Page

Date of Admission

13.12.30

Diagnosis

Temp.

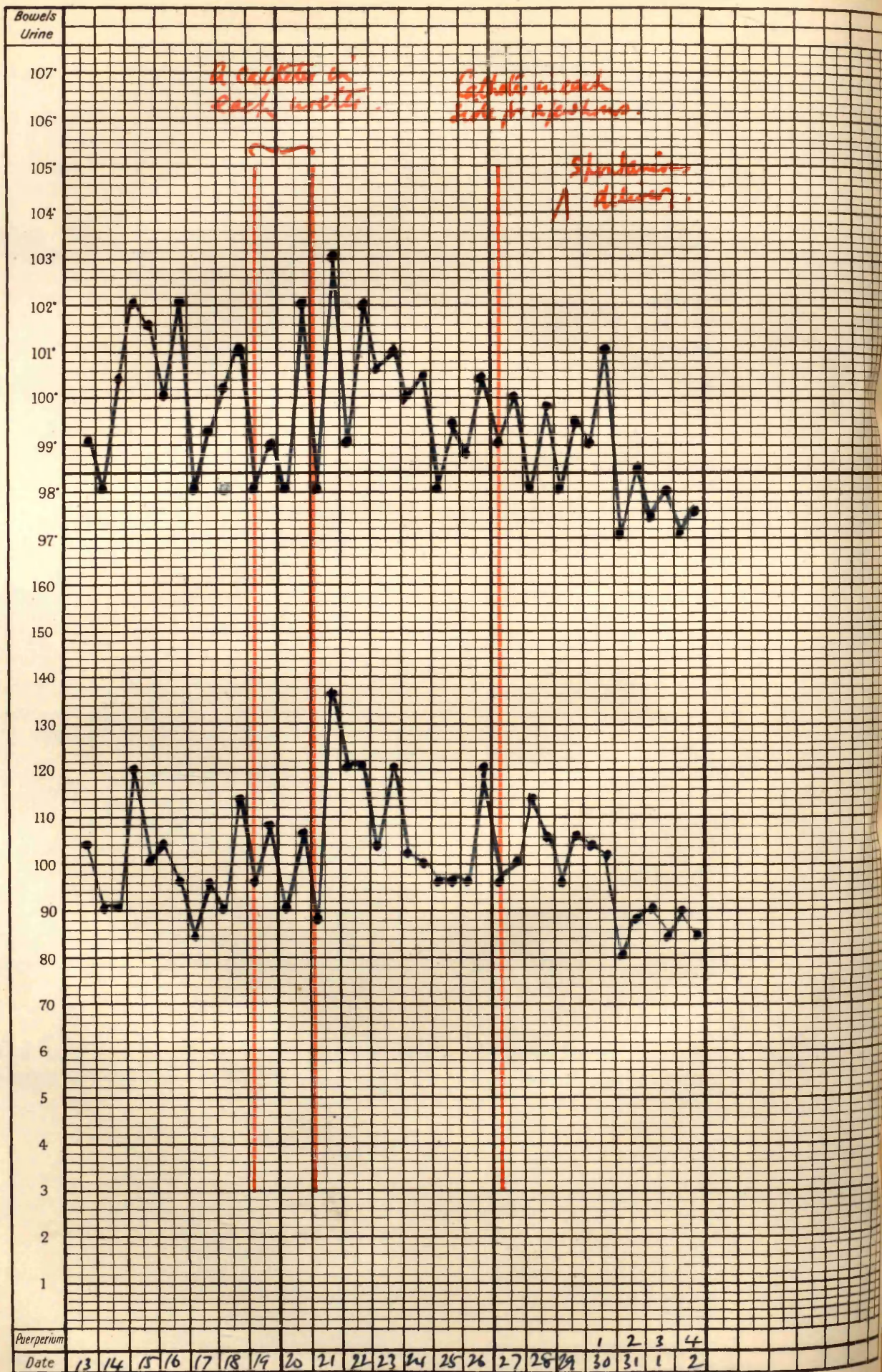
Case no. 34.

Pulse

Fundus

and/or

Albumen



Case sheet no. 34.

Mrs. O'N.

aet. 20

1st pregnancy

13-12-30. Admitted.

L.P. 16-6-30.

26 weeks preg.

Present pregnancy. Ill for 14 days before admission with pain in both kidney regions and high fever, lack of appetite and loss of weight.

Examination. Slight anaemia, no jaundice, slight emaciation, slight tenderness in both kidney regions.

19-12-30. Temp. 101° and pulse rate 100 - 120 since admission.

Catheters inserted into both ureters. Drained for 24 hours and then stopped. The chart shows that while the catheters were draining the temperature fell but rose again when drainage ceased.

27-12-30. Catheters again inserted but catheter in left ureter did not drain.

28-12-30. Bougies inserted as foetus was thought to be dead.

29-12-30. Miscarriage - child alive but died later.

Fever subsided almost immediately and pulse rate decreased.

This was one of the first cases treated by ureteral drainage and in the first place unsuitable catheters were used, which resulted in faulty drainage and in the second place the catheters were left in too long, since the ureters were only moderately dilated.

Bacteriological and Urological Examination.

13-12-30. Urine contains albumen +-, abundant pus cells and coliform organisms.

19-12-30. Urine from both kidneys heavily infected.

In 12 hours 220 ccs collected from right ureter.

" " " 152 " " " left "

Concentration of urea in R. kidney urine was 0.375%.

" " " " L " " " 0.468%.

28-12-30. Blood culture sterile.

Patient's serum does not agglutinate the organism in the urine.

13-1-31. Urea concentration test shows that the highest reading is 1.64%.

7-2-31. 6 weeks p.p. Urine contains no albumen and a very occasional pus cell and coliform bacillus.

14-3-31. Urine contains no albumen and is sterile.

Urea concentration test shows a maximum reading of 2.375%

I.C. left side 5 mins.

right " " " conc. fairly good at both sides.

2nd pregnancy.

Patient was well throughout the second pregnancy.

8-2-33. Spontaneous delivery - child alive 8lbs.

6 cystoscopic examinations were made during the pregnancy and no stasis was present at any time. In this case the recovery following the pyelitis in the first pregnancy was rapid and complete, the tone of the ureters being little affected, so that stasis did not develop with the second pregnancy.

Name Mrs P.

Age 25

Ward

Physician

Journal

Page

Date of Admission

30.8.31

Diagnosis

Temp.

Case no. 35.

Pulse

Fundus

and/or

Albumen

Bowels
Urine

107°

106°

105°

104°

103°

102°

101°

100°

99°

98°

97°

160

150

140

130

120

110

100

90

80

70

6

5

4

3

2

1

Puerperium

Date

30

1

2

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

Case sheet no.35. Mrs.P. aet.25 1st pregnancy
 30-8-31. Admitted. L.P. 24-2-31. 27 weeks pregnant.

Present pregnancy. When 4 months pregnant pain in the right side developed and became much worse one week before admission, when she had rigors and pain and frequency of micturition.

Examination. Temp. 103°, pulse rate 120. Well nourished, no oedema, no jaundice. Tenderness along right urinary tract.

6-9-31. Feels well but temp. and pulse rate still elevated. Ureteral catheter inserted on right side.

Removed 44 hours later, as although patient was comfortable temp. and pulse rate were unaffected.

Marked diuresis. 91 ozs passed by the catheter from the right kidney in 24 hours and 121 ozs from the bladder.

16-1-31. Temp. settled.

Urea concentration test highest reading was 1.2% in 3rd hour.

Blood urea 20 mgms. per 100 ccs.

Non protein nitrogen 14 mgms. per 100 ccs.

24-9-31. Dismissed.

4-12-31. Spontaneous delivery - child alive 5½ lbs.

14-12-31. Dismissed well.

3 months p.p. 7-3-32. Feels fairly well.

28-4-33. 17 months p.p. Headaches troublesome - B.P. 165/120.

18-8-33. Feels better, headaches only occasionally - B.P. 140/80.

Bacteriological and Urological Examination.

3-9-31. Blood culture sterile.

Urine contains albumen, fairly numerous pus cells and organisms.

5-9-31. Cystoscopic examination.

I.C. left side 6 mins.

right " none in 11 mins. Catheter passed

above pelvic brim and no dye tapped, but soon appeared.

10-9-31. Blood culture sterile.

27-1-32. 2 months p.p. Cystoscopic examination.

I.C. left side 4 mins.

right " " " conc. poor at

both sides.

7-3-32. Retrograde pyelogram, fig. , shows dilatation and clubbing of the calyces of the right kidney.

Concentration of urea of right kidney urine 0.35%.

" " " " left " " 0.53%.

" " " " bladder " " 0.50%.

Bladder urine contains no albumen and is sterile.

18-8-33. Chromocystoscopy shows no delay in excretion and the urine is sterile and contains no albumen.

In this case it seems likely that the infection of the kidney substance resulted in the polyuria and rise of blood pressure, which caused headaches. These are most unusual sequelae of infection.

Name Mrs K

Age 23

Ward _____

Physician _____

Journal _____

Page _____

Date of Admission

18.12.30

Diagnosis _____

Temp. _____

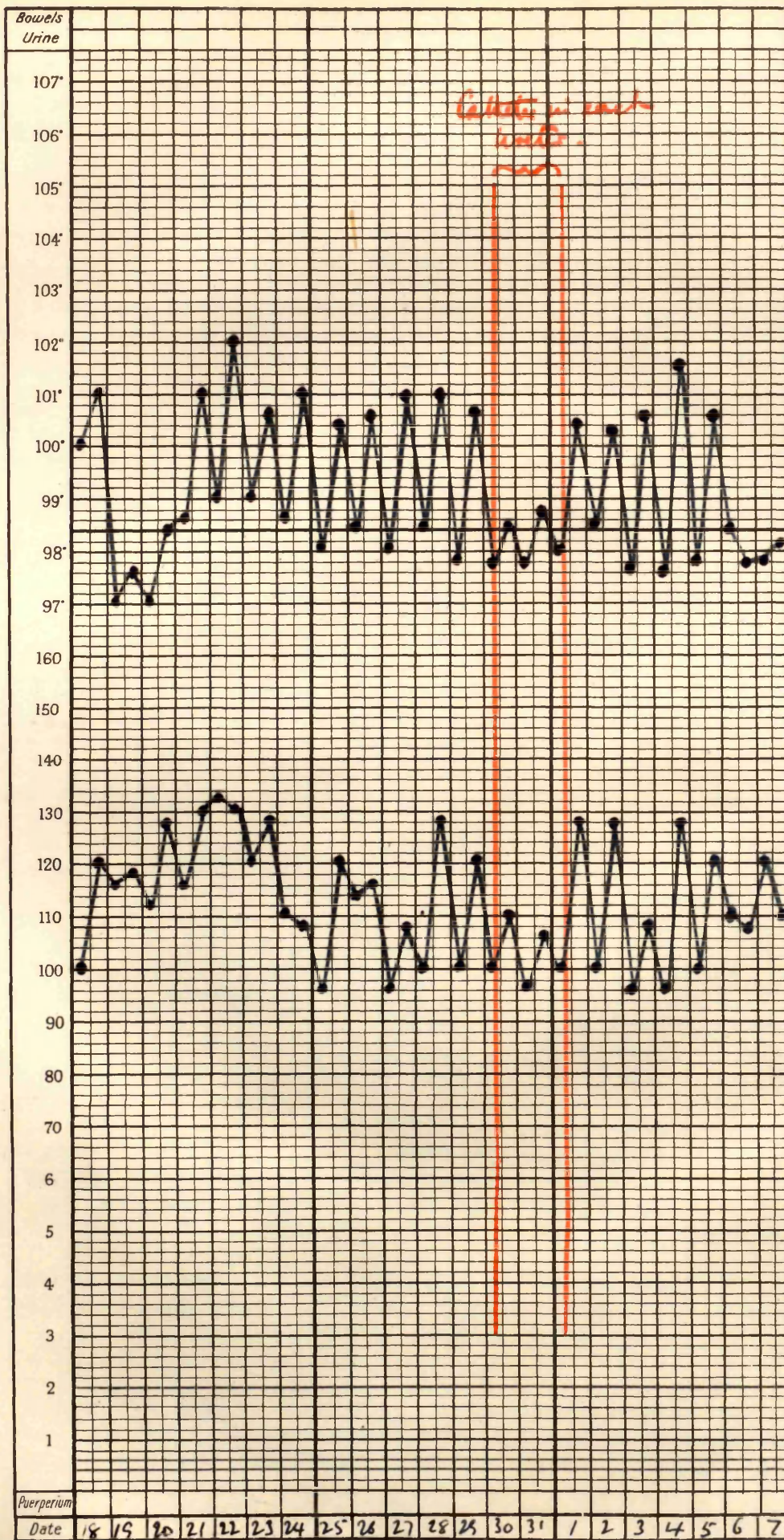
Case no. 36.

Pulse _____

Fundus _____

and/or

Albumen _____



Case sheet no.36. Mrs. K. aet.23 1st pregnancy
18-12-30. Admitted. L.P. 15-7-30. 25 weeks preg.

Present pregnancy. When in 4th month severe left sided pain with rigors and vomiting. 1 week before admission pain in the right side developed

Examination. Anaemia, loss of weight, slight jaundice, tenderness in both kidney regions.

- 30-12-30. Temp. swinging to 101° since admission, pulse rate 100 - 120. Patient dull and apathetic. Lack of appetite. Extreme tenderness along right urinary tract. Catheters inserted into both ureters, left in for 48 hours. While they are in position, temp. remained down and pulse rate was slower, and patient's general condition improved. Appetite returned. Temp. rose when catheters were removed but settled in a few days.
- 16-1-31. Dismissed.
- 26-1-31. Readmitted. Anaemia, loss of weight, jaundice, only slight tenderness.
- 12-2-31. Labour. Spontaneous delivery, child alive.
- 24-2-31. Dismissed.
- 28-3-31. Much better. Appetite good, no tenderness.

Bacteriological and Urological Examination.

- 30-12-30. Urine contains no albumen, abundant pus cells and coliform organisms. Urine from both kidneys infected.
In the 48 hours during which the catheters were in position, 41 ozs. drained from the right kidney and 18 ozs from the left, and 10 ozs. from the bladder, but bowels had moved 6 times when urine was also passed, so that although the right kidney appeared to excrete more than the left it is impossible to measure exact quantities.
I.C. injected before removal of catheters, and it appeared through the catheter at the right side in 4 mins., and at the left side in 5 mins.
- 6-2-31. 6th day p.p. I.C. right side 6 mins.
left " 11 " conc. poor.
- 17-2-31. Intravenous pyelogram - very poor shadows obtained.
- 28-3-31. Urine contains no albumen but abundant pus cells and coliform organisms.

2nd pregnancy.

Jan. 1933. Spontaneous delivery at full time, child alive 5½ lbs.

3rd pregnancy.

- 13-1-34. 7th month of pregnancy. Feels well, B.P. normal,
I.C. left side 5 mins.
right " " "
Tone of both ureters extremely good. Urine sterile.

Name Ann O'N
Age 23
~~Word~~
Physician _____
Journal _____
Page _____
Date of Admission 23.6.30
Diagnosis _____
Temp. _____

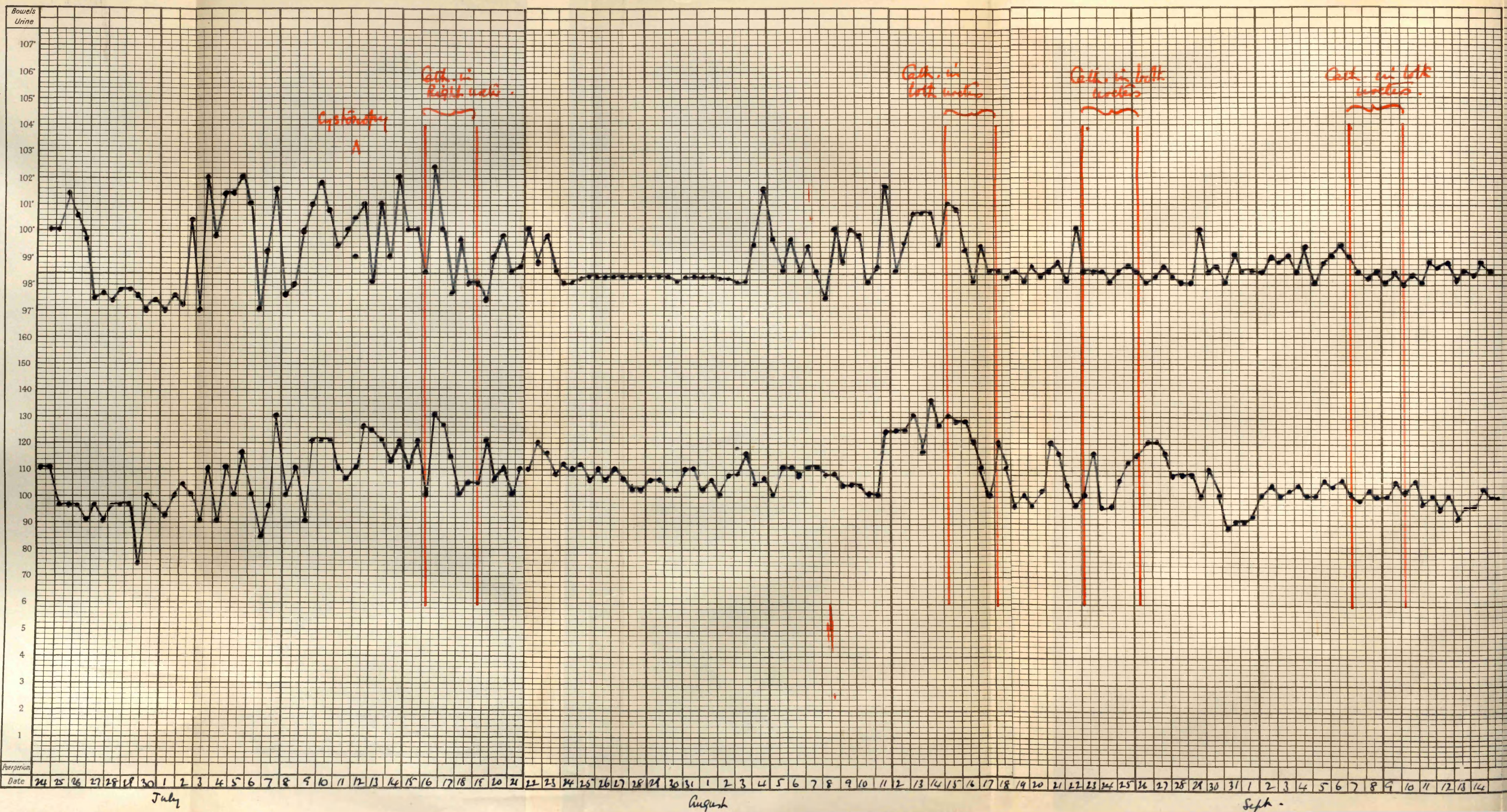
Pulse _____

Case 37.

Fundus _____

and/or

Albumen _____



Case sheet no.37. Mrs.O'N. aet.23 1st pregnancy
 23-6-30. Admitted. L.P. 10-1-30. 24 weeks preg.

Present pregnancy. Well until 1 week before admission, when she had severe right sided pain.

Examination. No anaemia, no loss of weight. Tenderness over right kidney, none on left side. Temp. 101°, pulse rate 100.

- 29-6-30. Temp. settled within 48 hours of admission.
 1-7-30. Temp. again rose.
 12-7-30. Patient looks very ill. Cystoscoped and lavage of right kidney carried out. Pain relieved temporarily but temp. did not settle.
 15-7-30. Still very ill. Catheter inserted into the right ureter and left in position.
 18-7-30. Catheter removed. Has drained well. Lavage has been carried out 4 times daily. Striking improvement in general condition, very much brighter and no vomiting.
 4-8-30. Patient not so well. Temp. elevated and severe left sided pain.
 13-8-30. Patient very ill, drowsy and face puffy. Catheter into each ureter. This caused immediate improvement and temp. settled quickly.
 22-8-30. Temp. rose again to 100°, catheters again inserted and left in for 4 days.
 6-9-30. Catheter inserted into each ureter for 3 days. Temp. again settled and condition improved.
 6-10-30. Dismissed.
 21-10-30. Readmitted in labour. Forceps delivery. Child alive 5½ lbs. Puerperium normal.
 7-11-30. 8 weeks p.p. I.C. showed that there is no delay in excretion.
 5-5-31. Feels well.

2nd pregnancy.

- 30-7-32. 4 months pregnant. Feels well apart from slight right sided pain.
 9-9-32. Pain in right kidney region but passed off quickly.
 25-10-32. Admitted because of sickness. Temp. normal, pulse 80-100.
 2-11-32. Dismissed.
 21-1-33. Spontaneous delivery, child alive 7 lbs.
 3-3-33. Feels well. Urine now sterile for the first time.

Bacteriological and Urological Examination.

- 23-6-30. Albumen -ve. Numerous pus cells and abundant coliform organisms, in urine.
 4-7-30. Blood culture -ve.
 12-7-30. Right kidney urine contains abundant pus cells and coliform organisms. Catheters passed into both ureters, and after kidney pelvis had been emptied, indigocarmine injected. Dye appeared at the left side in 1 min. and at the right in 5 mins. in poor conc.
 13-8-30. Urine from both kidneys heavily infected.
 2-9-30. Urea concentration test, highest reading 1.125% .
 23-9-30. Agglutination of the organisms in the urine did not occur with patient's serum.
 5-5-31. Intravenous pyelogram shows that kidney function was ~~was~~ ^{was} ~~gigged~~ ^{gigged}

and no stasis is present.

Urea concentration test, highest reading 1.9%.

5-9-31. I.C. 5 mins. left side.
" " right "

Right kidney urine contains a few coliform organisms only

30-7-32. I.C. left side 5 mins.
right " " "

Bladder urine contains a few pus cells and abundant coliform organisms.

27-8-32. I.C. left side 5 mins. good conc.
right " 7 " poor "

24-9-32. I.C. left side 5 " good conc.
right " 6 " very poor conc.

Intravenous pyelogram shows no dilatation of left urinary tract and only moderate dilatation of right, which shows completely in 25 mins.

19-10-32. I.C. left side 12 mins.
right " none in 15 mins.

23-11-32. None I.C. none in 15 mins. at either side.

Urine contains a haze of albumen, abundant pus cells and coliform organisms.

3-3-33. I.C. left side 5 mins.
right " " "

Urine sterile.

Name Mrs D.

Age 18

Ward

Physician

Journal

Page

Date of Admission 14.2.34

Diagnosis

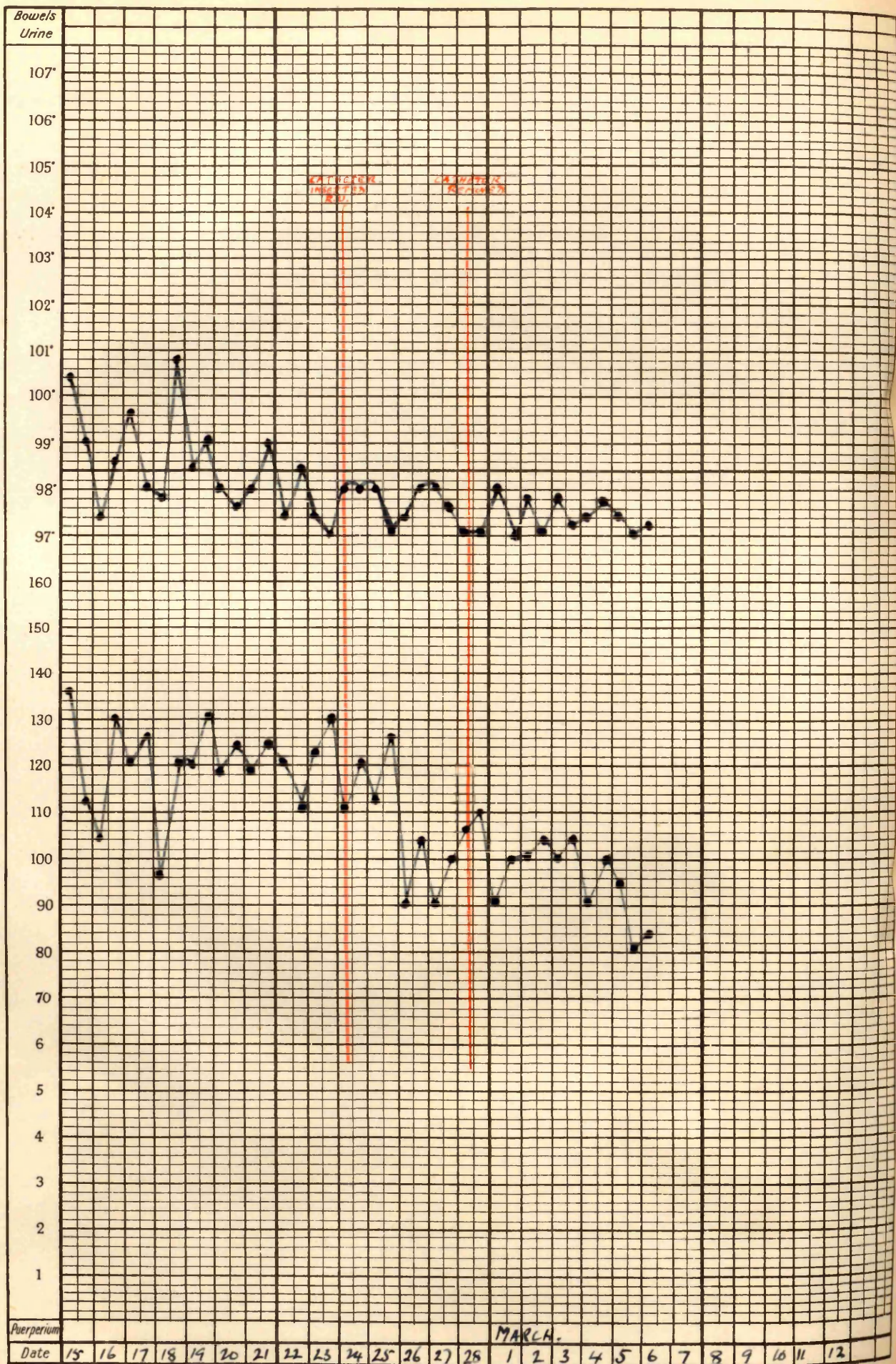
Temp

Pulse

Fundus

and/or

Albumen



Case sheet no.38.

Mrs.D.

aet 18

1st pregnancy

14-2-34. Admitted.

L.P. end of Aug.,1933.

24 weeks preg.

Present pregnancy. Health good until 2 weeks ago when vomiting began. Sleeplessness and lack of appetite.

Examination. No anaemia, no oedema, wellnourished, no tenderness, temp.100.4°; pulse rate 130.

24-2-34. Temp. has settled but pulse rate is till 120-130.

Cystoscopic examination . I.C. left side 6 mins. good conc. right " none in 10 mins.

No.14 catheter passed into right ureter and left in position.

Conc. of urea in left kidney urine 1.25%.

" " " " right " " 0.53%.

Catheter left in for 4 days during which time the patient's health improved and the pulse rate settled.

24 ozs of urine drained from the right kidney in 12 hours, and in the same time 28 ozs were passed from the bladder.

It is impossible to say how much ran past the catheter.

The urine contains haze of albumen, numerous pus cells and coliform organisms.

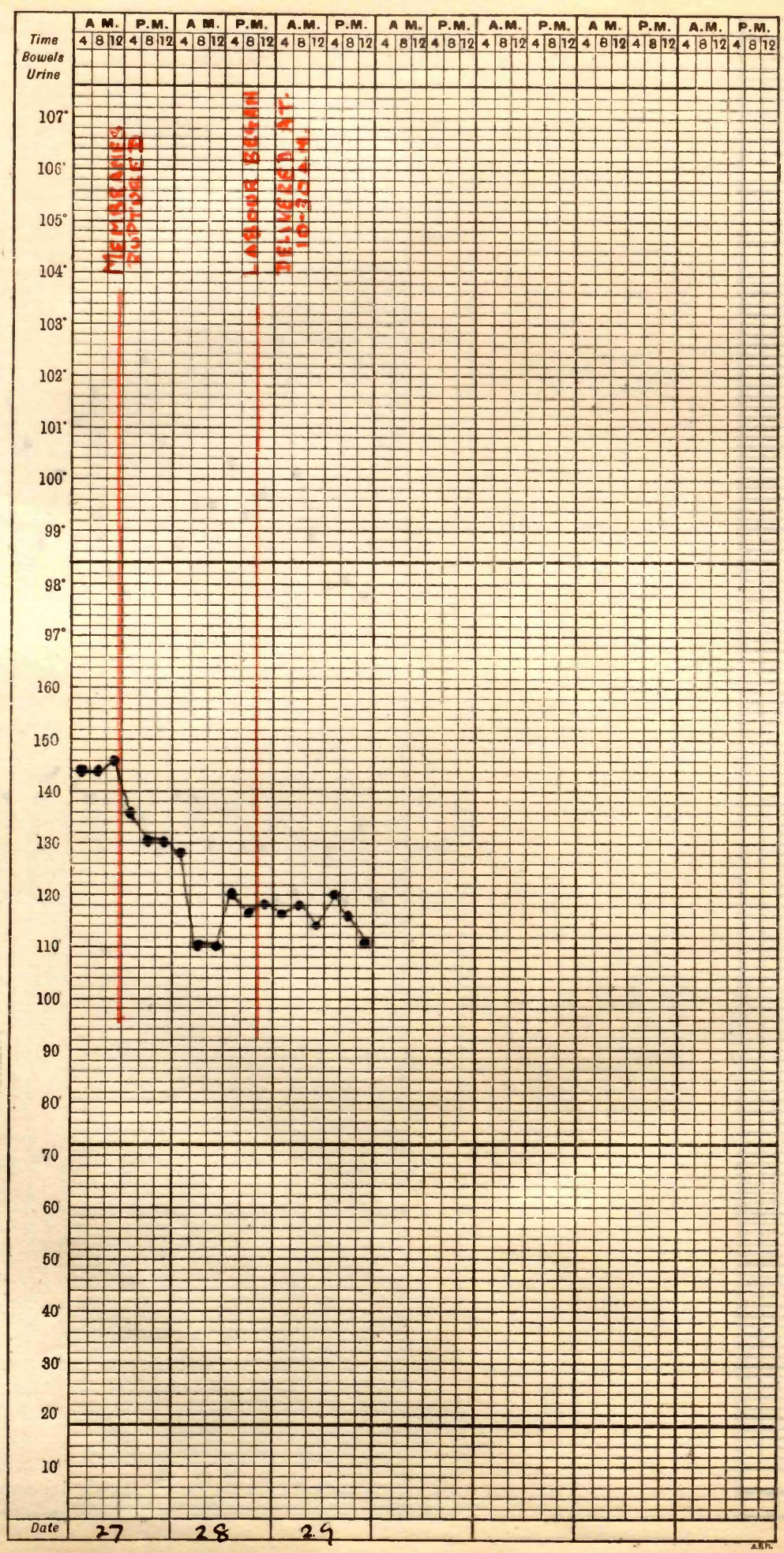
Right kidney urine contains a uniform suspension of organisms and a few pus cells, but no collection of pus was present in the right urinary tract, indicating a pyelonephritis rather than a pyelitis.

6-3-34. Dismissed improved.

Name Mrs D
 Age 35
 Ward _____
 Journal _____
 Page _____

Case no 39.

4 hourly
 pulse rate.



Date of Admission...
20.12.32

Case sheet no.39. Mrs.D. aet 35 9th pregnancy.
 20-12-32. Admitted. L.P.3-7-32 24 weeks pregnant.

Obstetric history. All full time normal pregnancies.

Present pregnancy. Since 9-12-32 sickness severe. Referred to hospital because of "albuminuria".

Examination. Looks ill, anaemic, no oedema, no tenderness, B.P.118/72.
 Temp.100°, pulse rate 110.

31-12-32. Temp. still 101°, pulse rate 130.

Cystoscopic examination. I.C. no dye at either side in 16 mins.

Catheter passed into each ureter and both kidney urines found to contain abundant pus cells and coliform organisms. Ureter tone very poor.

Catheters left in for 3 days during which time temp. and pulse rate fell and patient felt much better.

Immediately after removal of catheters temp. and pulse rate rose again.

4-1-33. Vomiting troublesome. Râles at right base.

12-1-33. Dullness at base of left lung.

20-1-33. Chest signs still the same. Ureteral catheters passed.

23-1-33. Condition much better. Sickness has stopped. Pulse still rapid. Catheters removed. Temp. immediately rose after removal.

27-1-33. Membranes ruptured - 55 ozs. fluid drained off, which caused immediate improvement in patient's condition, and pulse rate fell, see 4 hourly pulse rate.

28-1-33. 8a.m./ Labour began.

10.30 am. Spontaneous miscarriage.

7-2-33. Dismissed.

30-6-33. Feels well. I.C. left side 4 mins. good conc.
 right " 6 " " "

Tone of right ureter now much improved. Urine sterile, but contains albumen +-.

Retrograde pyelogram on the 8th day postpartum, fig.117, shows ptosis of right kidney with dilatation and atony of urinary tract. In this case the improvement resulting from ureteral drainage was not maintained because of the poor tone of the ureters. The relief of pressure when the membranes were ruptured was enough to cause improvement in the patient's condition.

Name Mrs P.

Age 26

Married

Physician

Journal

Page

Date of Admission

15-11-32

Diagnosis

Temp.

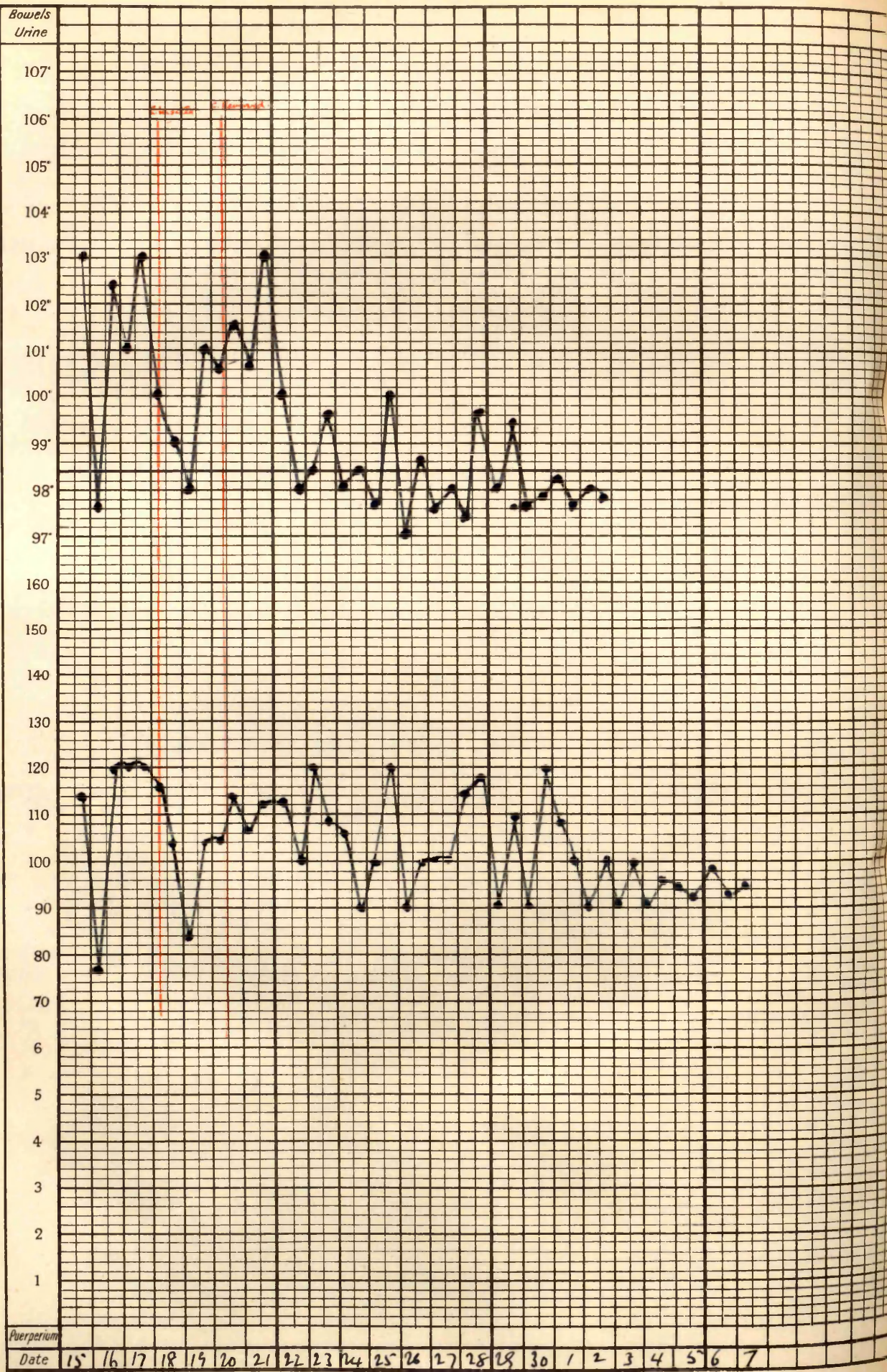
Case no. 40.

Pulse

Fundus

and/or

Albumen



Case sheet no.40. Mrs.P. aet 26 1st pregnancy.

15-11-32. Admitted. L.P. 29-4-32. 28 weeks preg.

Present pregnancy. Well until 2 weeks ago when severe pain in the back and right side of abdomen developed.

Examination. Temp. 103°, pulse rate 110. Slight anaemia, sickness and lack of appetite. No jaundice or oedema. B.P.124/84
Tenderness over right side of abdomen.

18-11-32. Temp. and pulse rate still elevated.

Cystoscopic examination. Some cystitis.

I.C. left side done in 8 mins.

right " " " " "

No.14 catheter passed into right ureter and dye in good conc. tapped above the pelvic brim. Pain disappeared almost immediately.

19-11-32. Temp. and pulse rate have settled quickly but 20 ccs of acriflavine used for lavage now cause severe pain, and temp. rose thereafter.

20-11-32. Catheter removed.

21-11-32. Feels well still no pain. Urine contains a haze of albumen, abundant pus cells and organisms.

10-12-32. Dismissed.

The pregnancy went to full time and ^{she} had a spontaneous delivery and normal puerperium.

In this case the catheter should have been removed at the end of 24 hours, as the tone of the ureter by that time had improved.

Name Mrs F.

Age 20

Ward _____

Physician _____

Journal _____

Page _____

Date of Admission _____

Diagnosis _____

Temp. _____

Case no. 41

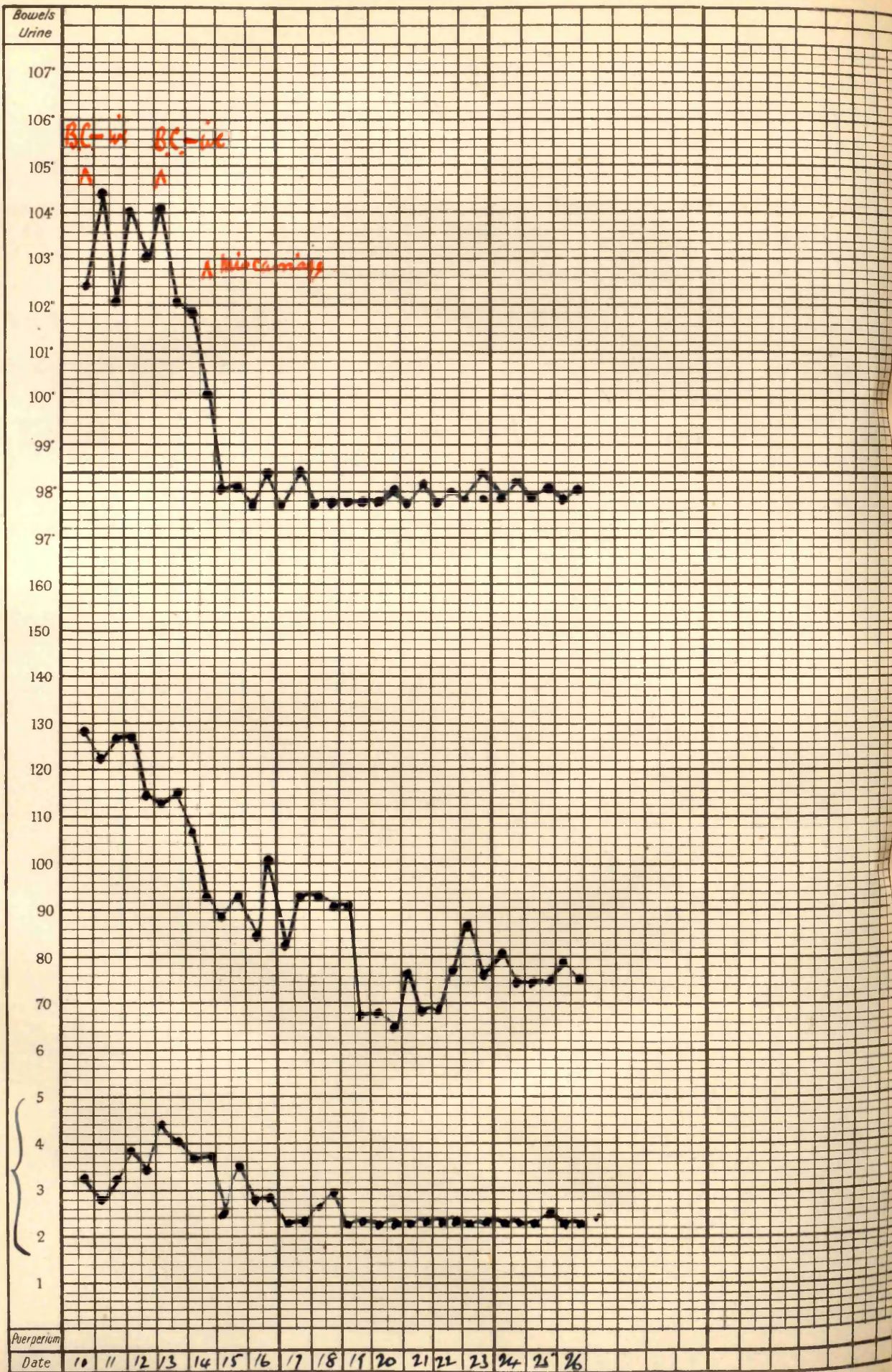
Pulse _____

Fundus _____

and/or

Albumen _____

Respirations



Case sheet no.41. Mrs.F. aet 18 1st pregnancy.
 10-8-31.Admitted. L.P.9-3-31. 22 weeks preg.

Present pregnancy. Well until 1 week ago, when she developed sudden severe right sided pain, pain and frequency of micturition, sickness and vomiting and had several rigors. Sent in as a case of pneumonia.

Examination. Very flushed, tongue furred and dry. Respirations rapid dullness at base of right lung, slight cough. No oedema or jaundice. Extreme tenderness over right kidney.

B.P. 100/60.

Urine contains albumen + , abundant pus cells and coliform organisms.

11-8-31. Condition still acute.

14-8-31. Attempt made to make a cystoscopic examination but cervix found to be fully dilated and membranes bulging. Miscarriage occurred shortly after . Temp. and pulse rate settled, immediately.

Renal colic in this case probably induced uterine contractions.

No. 42.

CHART OF SUBSEQUENT PREGNANCIES in cases of
PYELITIS of PREGNANCY.

Case	1 st	2 nd	3 rd	4 th	Remarks.
1	Pyelitis F.T.	Left sided pain.F.T.			
2	P.	F.T. Well	F.T.		7 months later. Well. (Urine -ve)
3	P.	F.T.	P. F.T.	Well F.T.	3 yrs. later - Debility (Urine -ve)
4	P.	4 mths. P.	F.T.		3 yrs. later - Well (Urine -ve)
5	P.	6½ m. P.	F.T.		1½ yrs. Well (Urine -ve)
6	P.	4½ m. P.	8 m.		2½ yrs. Frequency (Urine +ve)
7	P.	4 m. Eclampsia.	F.T.		8 m. Well (Urine -ve)
8	P.	6 m.	N.F.T.	N.F.T.	P. 4½ m. 1½ yrs. Lt. sided pain (Urine +ve)
9	P.	F.T.	N.F.T.		4 m. Well (Urine -ve)
10	P.	4 m.	N.F.T.		5 m. Well (Urine -ve)
11	P.	F.T.	P. F.T.		
12	P.	F.T.	P. F.T.	Kidney Pain.F.T.	Urine +ve
13	P.	8 m.	N.F.T.		8 m. Well (Urine +ve)
14	P.	5 m. P.	F.T.	P. F.T.	2 m. Well (Urine +ve)
15	P.	8 m.	N.F.T.	N.F.T.	Urine -ve
16	P.	6 m.	N.F.T.		
17	P.	8 m. P.	4½ m.	N.F.T.	P. F.T.
18	P.	5 m.	N.F.T.	N.F.T.	3 m. Well (Urine -ve)
19	P.	4 m.	N.F.T.	P. A.P.H. 6½ m	P. 4 th F.T. P. 5 th F.T.
20	P.	6 m.	N.F.T.		
21	P.	8 m. P.	F.T.		2½ yrs. L. Kidney Pain (Urine +ve)

Case	1 st	2 nd	3 rd	4 th	Remarks
22	P. F.T.	P. F.T.	P. F.T.		5m. p.p. Lt. sided pain. (Urine +)
23	P. 8m.	P. F.T.			1yr. not well (Urine +ve)
24	P. F.T.	P. F.T.			
25	P. 6m.	N.F.T.			
26	P. 7m.	P. 8m.			
27	P. 7 $\frac{3}{4}$ m.	P. F.T.			
28	P. 8m.	P. 7m.	P. 6m.		
29	P. 7m.	N.F.T.			
30	P. F.T.	Abortion 3m.			
31	P. 8m.	N.F.T.			
32	P. F.T.	N.F.T.			
33	P. 8m.	N.F.T.			
34	P. F.T.	P. F.T.	P. F.T.	P. 8m.	
35	P. 8m.	P. F.T.	P. F.T.	P. 4 th F.T. P. 5 th F.T.	
36	P. 8m.	P. F.T.			
37	P. F.T.	P. 8m.			
38	P. 7m.	P. 7m.	N.F.T.	P. F.T.	Died. T.B.?
39	P. 7m.	P. 7m.	P. 7 $\frac{1}{2}$ m.		8m. Well (Urine +ve)
40	P. 6m.	N.F.T.			
41	P. F.T.	Anaemia F.T.			
42	P. 6m.	P. 8 $\frac{1}{4}$ m.	P. F.T.		1yr. Pale, pain in back (Urine +ve)
43	P. 8m.	N.F.T.			
44	P. 5m.	N.F.T.			

Case	1 st	2 nd	3 rd	4 th	Remarks.
45	P. F.T.	N.F.T.			
46	P. 6½m.	N.F.T.	N.F.T.		3½ yrs. Well (Urine -ve)
47	P. 8¼m.	Missed abortion 2½m.	N.F.T.		
48	P. 5m.	P. F.T.	N.F.T.	N.F.T.	
49	P. 5m.	P. F.T.			
50	P. 6m.	P. 5m.			4m. Rt. sided pain, poor health. (Urine -ve)
51	P. F.T.	N.F.T.			14m. Pale, weak. (Urine -ve)
52	P. 7m.	Rt. sided pain. F.T.			1½m. Still pain. (Urine -ve)
53	P. F.T.	Alb. ++. F.T.	Eclampsia Pyuria		
54	P. 7m.	P. 7½m.	8½m.		2m. Well (Urine -ve)
55	P. 5m.	N.F.T.			2m. Well. (Urine - a few Staph)
56	P. F.T.	P. F.T.			2 yrs. Well. (Urine +ve)
57	P. F.T.	P. F.T.			5m. Rt. sided pain. (Urine -ve)
58	P. F.T.	P. F.T.			6m. Ill. (Urine +ve)
59	P. F.T.	P. F.T.			
60	P. F.T.	P. F.T.			1 yr. Well. (Urine +ve)
61	P. 4m.	N.F.T.			1¼ yrs. Well. (Urine -ve)
62	P. F.T.	P. F.T.			1m. Pale. (Urine -ve)
63	P. F.T.	P. Twins. 4m. No symptoms.			
64	P. F.T.	P. F.T.			
65	P. F.T.	P. F.T.			2m. Urine -ve.

Case	Primary Attack										Remarks.
66	5 th P.	F.T.	6 th P.	F.T.	7 th P.	F.T.	8 th P.	F.T.	1½ yrs.	Abdominal pain (Urine +ve)	
67	3 rd P.	F.T.	4 th P.	F.T.	5 th P.	F.T.	7 th P.	F.T.	Ureteral Stricture (Urine +ve)		
					6 th P.	F.T.	8 th P.	F.T.			
68	5 th P.	F.T.	6 th P.	F.T.							
69	7 th P.	F.T.	8 th N.	F.T.	9 th Hysterotomy + Sterilisation.				Kidney removed for stone before 8 th preg. Urine -ve		
70	6 th P.	F.T.	7 th P.	F.T.	9 th P.	F.T.	11 th P.	F.T.	1 yr. Stricture. (Urine +ve)		
			8 th P.	F.T.	10 th P.	F.T.	12 th Hysterotomy.				
71	6 th P.	F.T.	7 th miscarriage	4½m.					4 m. Not well. (Urine -ve)		
72	2 nd P.	7m.	3 rd N.	F.T.					Urine -ve		
73	6 th P.	8m.	7 th cystitis - abortion.								
74	3 rd P.	F.T.	4 th Haematuria	F.T.	5 th Hysterotomy	4m.			4 m. Bilateral renal calculi.		
75	5 th P.	4m.	6 th miscarriage	4m.					2 yrs. Poor health. (Urine +ve)		
76	5 th P.	F.T. s.B.	6 th P.	8m.	8 th not well.	8½m.	10 th R. sided pain. Hysterotomy 4m. Sterilisation.		Urine -ve		
			7 th not well	F.T.	9 th R. sided pain.	F.T.					
77	5 th P.	4m.	6 th	8m.					1½ yrs. not well. pain in back. (Urine sterile)		
78	2 nd P.	F.T.	3 rd N.	F.T.	4 th N.	F.T.					
79	2 nd P.	F.T.	3 rd P.	F.T.							
80	3 rd P.	F.T.	4 th Well. Urine +ve cystitis.	F.T.							
81	4 th P.	8½m.	5 th P.	F.T.	6 th P.	F.T.					
82	5 th P.	F.T.	6 th P.	8½m.							
83	3 rd P.	F.T.	4 th P.	5m.	6 th P.	5m.	8 th Hysterotomy 3m. and sterilisation				
			5 th P.	4m.	7 th P.	6m.					
84	2 nd P.	F.T.	3 rd P.	Induction at 4m.					Death due to Pyelitis.		
85	3 rd P.	F.T.	4 th P.	8m. s.B.					1¾ yrs. Lt. sided pain (Urine +ve)		
86	2 nd P.	8m.	3 rd P.	F.T.					1 yr. Pain in both sides. (Urine +ve)		
87	2 nd P.	8m.	3 rd P.	F.T.							

Case	Primary Attack	Remarks.
88	2 nd P. 8m. 3 rd N.F.T. 4 th P. F.T. 5 th P. F.T.	
89	4 th P. F.T. 5 th N.F.T.	Urine + ^{ve}
90	3 rd P. 8m. 4 th N.F.T.	Urine - ^{ve} .
91	3 rd P. 8½m. 4 th P. F.T.	10m. Urine + ^{ve}
92	10 th P. F.T. 11 th P. F.T.	2½ yrs. Frequency. (Urine + ^{ve})
93	4 th P. F.T. 5 th P. F.T. 7 th not well F.T. 9 th P. F.T. 6 th not well F.T. 8 th " " mis. 8m. Pain. Bilat. infection	
94	3 rd P. F.T. 4 th P. F.T.	
95	4 th P. 3m. 5 th P.	
96	3 rd P. F.T. 4 th P. F.T.	1 yr. Bladder symptoms. (Urine + ^{ve})
97	3 rd P. F.T. s.B. 4 th urine - ^{ve} ; Abortion.	
98	2 nd P. F.T. 3 rd P. F.T.	13m. Abdominal pain (urine - ^{ve})
99	2 nd P. F.T. 3 rd P. F.T.	1½ yrs. L. sided tenderness. (Urine - ^{ve})
100	8 th P. F.T. 9 th P. F.T.	8m. R. Kidney urine + ^{ve} No urinary symptoms. Not well.
101	5 th P. 8m. 6 th Albuminuria 8m.	2½ yrs. L. sided pain. Well. (Urine - ^{ve})
102	5 th P. F.T. 6 th A.P.H. 7m.	2½ yrs. Well, frequency. (Urine + ^{ve})
103	4 th P. F.T. 8 th N. F.T.	5m. urine - ^{ve}
104	3 rd P. F.T. 4 th P. F.T. 5 th P. F.T.	5 wks. anaemic. (Urine + ^{ve})
105	5 th P. 7m. 6 th miscarriage. 7 th P. A.P.H. 7m.	4 yrs. Well (Urine - ^{ve})
106	2 nd P. F.T. 3 rd High B.P. F.T.	1¾ yrs. Well. High B.P. (Urine + ^{ve})
107	3 rd P. F.T. 4 th P. F.T. 5 th P. F.T.	2 yrs. Poor health. (Urine + ^{ve})
108	2 nd P. 8¼m. 3 rd debility. F.T.	2½ yrs. Not well. Pain on both sides. (Urine - ^{ve})
109	6 th P. F.T. 7 th N.F.T.	9m. Well. (Urine - ^{ve})

Case	Primary Attack.				Remarks.
110	8 th P.	F.T.	9 th N.F.T.	10 th N.F.T.	4 yrs. Well.
111	5 th P.	F.T.	6 th N.F.T.	7 th well	
112	8 th P.	8m.	9 th N.F.T.	10 th P. ^{Caesarean section 8m. Sterilised.}	Urine + ^u
113	10 th P.	F.T.	11 th miscarriage	4 1/2 m.	15 m. Pain in back + on micturition. (Urine - ^u)
114	5 th P.	F.T.	6 th P	F.T. 7 th P. F.T.	
115	3 rd P.	F.T.	4 th P.	F.T. 5 th P. 5m. 6 th P. F.T. 7 th P. ^{Right kidney infected.}	
116	3 rd P.	9m.	4 th Twins	N.F.T. 5 th N.F.T.	4 m. Debility, nervous, no urinary symptoms (Urine + ^u)
117	2 nd P.	9m.	3 rd N.F.T.	4 th not well F.T. ^{pain in sides.}	Urine - ^u
118	5 th P.	F.T.	6 th N.F.T.	7 th anaemia F.T.	Urine - ^u
119	4 th P.	F.T.	5 th not well.	F.T.	4 m. not well, pain in sides, tenderness over R.K. (Urine + ^u)
120	13 th P.	F.T.	14 th abortion	1m.	1 yr. Well (Urine + ^u)
121	3 rd P.	F.T.	4 th P.	F.T. 5 th anaemia F.T.	9 m. Pain in back + on micturition. Tender over kidneys (Urine + ^u)
122	3 rd P.	F.T.	4 th N.F.T.		1 yr. Well (Urine - ^u)
123	6 th P.	F.T.	7 th P.	F.T.S.B. 8 th P. F.T.S.B.	
124	2 nd P.	F.T.	3 rd N.F.T.	4 th not well. F.T.	10 days. Well. (Urine + ^u)
125	2 nd P.	F.T.	3 rd well	6m. 4 th pain in back. ^{2/12.}	Urine (- ^u)
126	9 th P.	F.T.	10 th P.	6m.	3 yrs. Pain in sides. (Urine - ^u)
127	6 th P.	F.T.	7 th hydrannia	F.T. 8 th well.	Urine - ^u
128	5 th P.	F.T.	6 th P.	F.T.	3 yrs. Lt. sided pain. (Urine - ^u)
129	6 th P.	F.T.	7 th P.	F.T.	1 1/2 yrs. debility (Urine - ^u)
130	6 th P.	F.T.	7 th P.		
131	3 rd P.	F.T.	4 th N.F.T.		
132	2 nd P.	F.T.	3 rd P.	F.T. 4 th P. 8 1/2 m. 5 th P.	

Name Mrs D

Age 18

Ward _____

Physician _____

Journal _____

Page _____

Date of Admission
3-14-33

Diagnosis _____

Temp _____

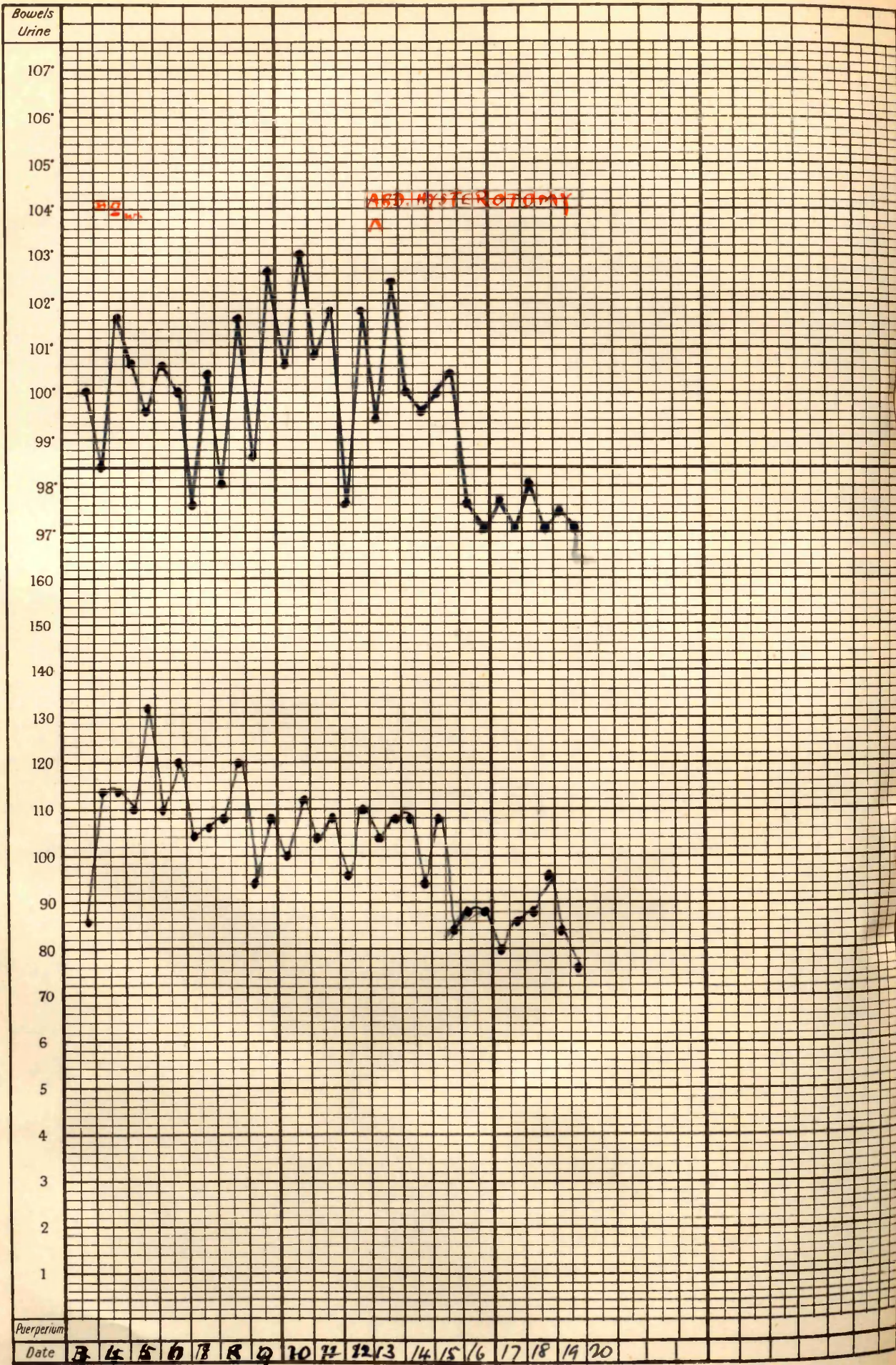
Case no. 43.

Pulse _____

Fundus _____

and/or

Albumen _____



April.

Case sheet no. 43.

Mrs.D. aet 18

1st pregnancy.

3-4-33. Admitted.

L.P. Nov. 1932.

About 20 weeks preg.

Present pregnancy. Sickness and vomiting and pain across back for 3 weeks before admission.

Examination. Anaemia, skin dry, tongue coated, no oedema, no enlargement of heart but mitral and aortic murmurs. Extreme tenderness over right kidney, and slight over left.

12-4-33. Temp. swinging to 102°,
Cystoscopic examination. I.C. left side none in 20 mins.
right " " " " "

Catheter passed into left ureter and I.C. tapped above pelvic brim in good conc. Pain relieved immediately. Catheter could not be passed more than 2 cms. into right ureter.

Bladder urine contains albumen ++, abundant pus cells and fairly numerous coliform organisms.

Left kidney urine contains abundant pus cells and a few coliform organisms.

13-4133. Abdominal hysterotomy performed. Temp. settled immediately.

2-5-33. (19th day p.p.) Retrograde pyelogram ,fig.118, shows that both urinary tracts are undilated.

A catheter now passes easily into the right ureter.

Bladder urine is sterile.

Urea concentration of bladder urine is 0.97%.

"	"	" R.kidney	"	"	1.14%
---	---	------------	---	---	-------

" " " L. " " " 1.83%.

This case shows the rapid recovery which may occur after termination of the pregnancy. It also shows that although the pyelogram is normal in appearance the urea concentration is very much lower at the right side than at the left, indicating damage to kidney substance, rather than to the urinary tract.

Name Mrs C.
 Age 20
~~Ward~~
 Physician _____
 Journal _____
 Page _____
 Date of Admission 15.10.27
 Diagnosis _____
 Temp. _____

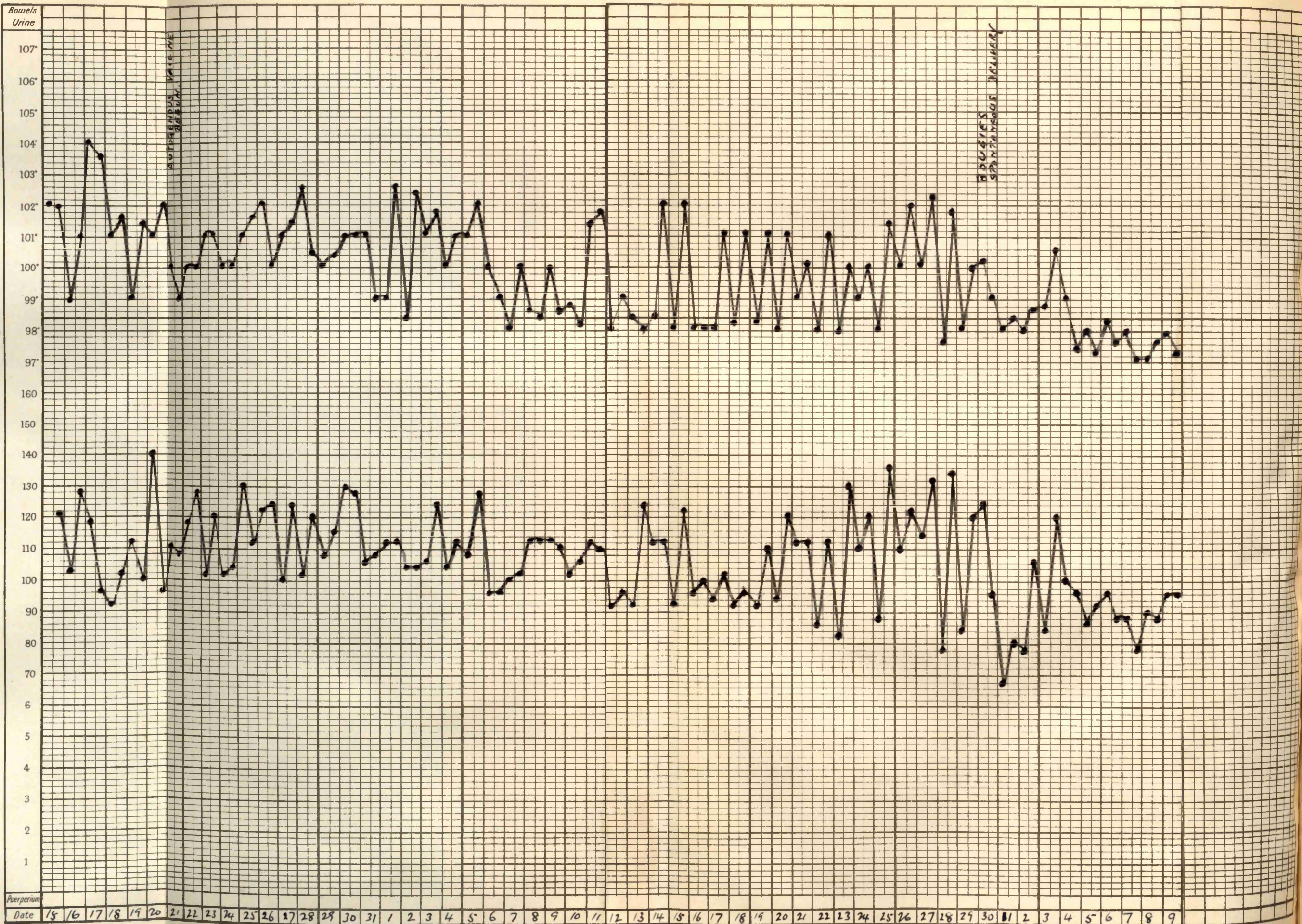
Case no 44.

Pulse _____

Fundus _____

and/or

Albumen _____



Oct. 1927

Nov. 1927

Dec.

Case sheet no.44. Mrs.C. aet 20 1st pregnancy.

15-10-27. Admitted. L.P. 15-4227 26 weeks pregnant.

Present pregnancy. Well till 3 days before admission when she developed pain on micturition and 2 days later tenderness over right kidney region and along right ureter. Vomiting but no rigor.

Examination. Tongue dry and furred, patient very weak, tenderness along right urinary tract.
Urine contains abundant pus cells and numerous coliform organisms.

28-10-27. Still very tender over right kidney. Temp. 102°, pulse rate 120.

31-10-27. Autogenous vaccine started.

26-11-27. Still having vaccine. Temp. swinging, patient anaemic and emaciated.

30-11-27. In-duction of labour by bougies.

13-12-27. Feels well.

24-1-28. Pyelogram shows moderate dilatation of right calyces and kidney pelvis.

1-6-28. Has been treated with repeated renal lavage but urine from right kidney still heavily infected.

8-6-29.

2nd Pregnancy.

L.P. 20-12-28.

8-6-29. Well till 4 days ago when a severe right sided pain and rigors developed. Admitted to hospital.
Anaemic and slight jaundice, moderate tenderness over right kidney. Temp. 102°, pulse rate 120.

11-6-29. Temp. and pulse rate settled.

Urine contains numerous pus cells and coliform organisms.

Sugar reactions 77-++AC-+ , same as in first pregnancy.

29-6-29. Dismissed.

10-9-29. Readmitted in labour. Spontaneous delivery, child alive 6½ lbs.

Puerperium normal.

Irregular dismissal on 10th day postpartum.

3rd pregnancy

2-9-31. Has been well since last child was born. L.P. 1-4-31.

Right side pain developed several days ago. Lack of appetite easily tired and thin.

Cystoscopic examination.

I.C. left side 8 mins.

right " none in 30 mins.

Catheter passed into right ureter, I.C. tapped above pelvic brim in poor conc. Tenderness disappeared.

5-9-31. Admitted to hospital. Rigor .

11-9-31. Temp. settled.

Urea conc. test bladder urine highest reading is 1.4%.

Organism in urine is the same as before with same sugar reactions. ~~27-11-31~~

27-11-31. Pain troublesome at times.

Name Mrs C

Age 21

Ward _____

Physician _____

Journal _____

Page _____

Date of Admission _____

8.6.29

Diagnosis _____

Temp. _____

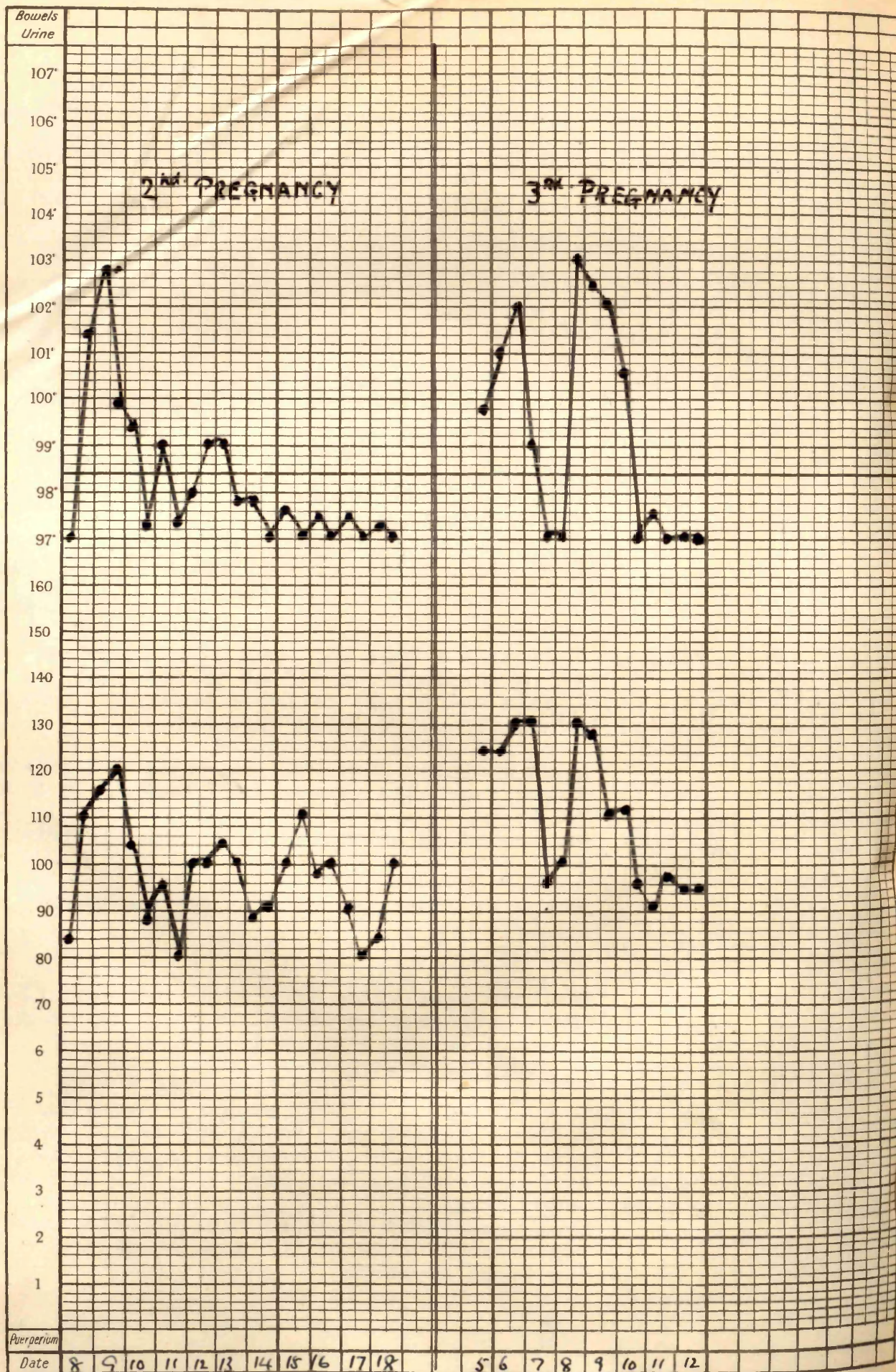
Case no. 44

Pulse _____

Fundus _____

and/or

Albumen _____



June 1929

Sept 1931

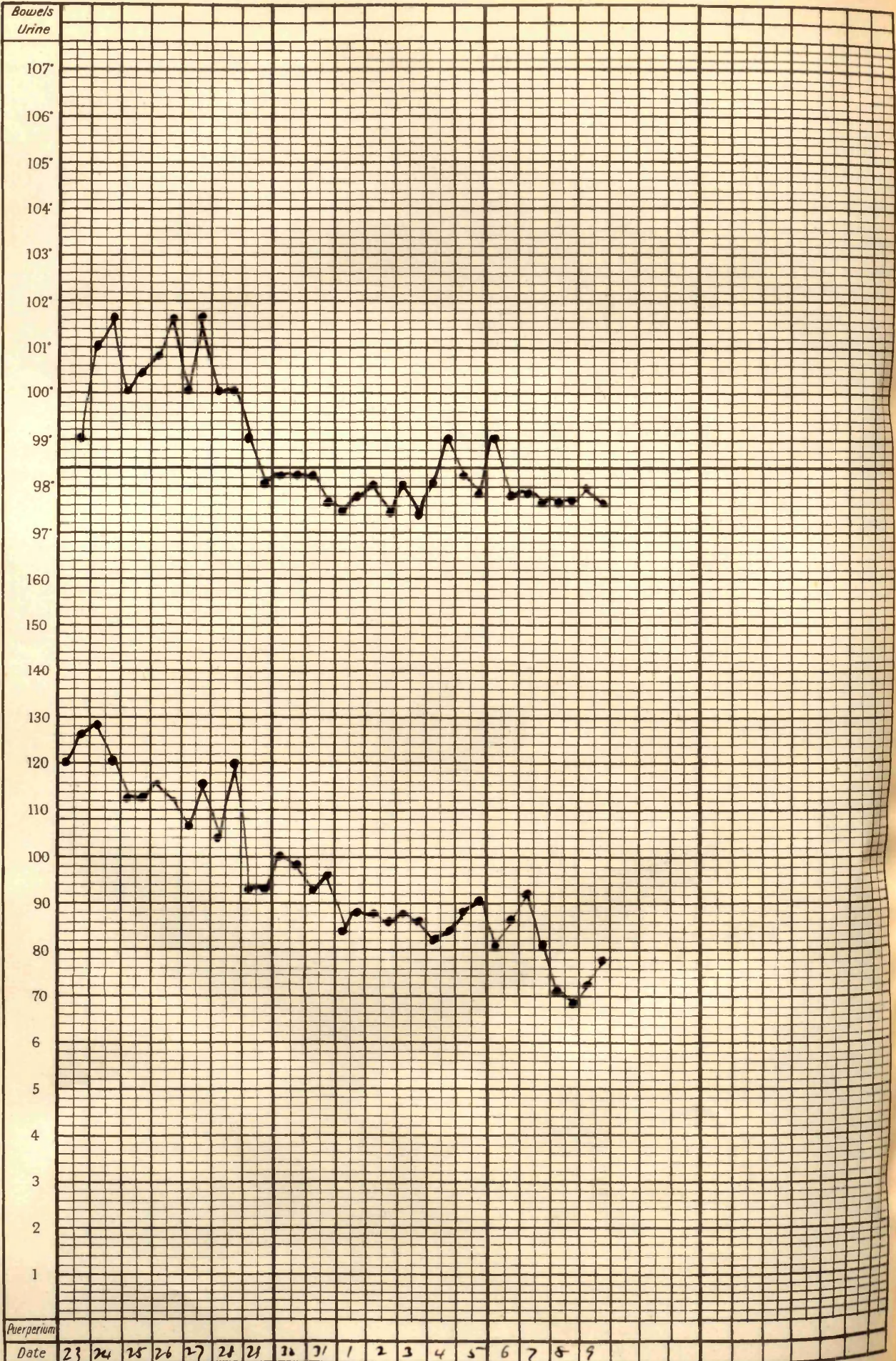
- 27-11-31. Cystoscopic examination. Some cystitis, no I.C. at either side in 15 mins.
- 30-12-31. Cystoscopic examination. I.C. left side none in 10 mins.
right " " " " "
but pus oozing through right orifice. Catheter passed in-
to right ureter. No dye tapped above pelvic brim until
catheter had been in position for 14 mins.
- 4-1-32. Admitted in labour. Spontaneous delivery, child alive,
7 $\frac{3}{4}$ lbs.
- 14-1-32. Dismissed.
- 28-1-33: Pain in the back at times. Still thin and anaemic. Pain
is worse before and during the periods.
Cystoscopic examination. Cystitis.
I.C. left side 6 mins.
right " 8 "
- Urine contains albumen +-, abundant pus cells and coli-
form organisms.
- 10-2-33. Admitted to Glasgow Royal Infirmary for treatment by
ketogenic diet, which however failed to sterilise the urine.

This patient had pyelitis with each of her 3 pregnancies, the attack becoming less severe with each, although the urine was just as heavily infected. Between pregnancies although the urine remains infected she feels much better and stasis in the urinary tract disappears. A certain immunity to the infection has apparently been acquired.

Name Mrs B
 Age 24
~~Ward~~
~~Physician~~
 Journal _____
 Page _____
 Date of Admission
20-10-27
 Diagnosis _____
 Temp. _____

Case no 45.
1st Pregnancy
 Pulse _____

Fundus _____
 and/or
 Albumen _____



Case sheet no. 45. Mrs. B. aet. 22. 1st pregnancy.

23-10-27. Admitted. L.P. 24-4-27. 26 weeks pregnant.

Present pregnancy. Well till 5 days before admission, when she had severe pain on right side with shivering attacks, vomiting and pain and great frequency of micturition.

Examination. Slight jaundice, tongue dry, temp. 101.8°, pulse rate 120. Tenderness over right kidney and in right iliac fossa. Urine contains abundant pus cells and coliform prgs, whose sugar reactions are ++--AC--

30-10-27. Temp. and pulse rate settled.

13-11-27. Dismissed.

17-11-27. Readmitted in labour. Temp. 103°. Spontaneous delivery, 2½ lbs, stillborn. Uneventful puerperium.

25-11-27. Dismissed.

L.P. 10-8-28.

2nd pregnancy.

7-3-29. Admitted. 30 weeks pregnant.

Present pregnancy. Well till 4 months when she developed right sided pain and has been confined to bed since then.

Examination. Anaemic, eyes sunken, no tenderness, no sickness or vomiting. Afebrile, pulse rate 100.

17-3-29. In labour. Spontaneous delivery, child lived for 48 hours, 4½ lbs.

27-3-29. Dismissed.

1-6-29. Feels well except for occasional attacks of right sided pain.

Retrograde pyelogram shows dilatation of right calyces and slight dilatation of right ureter. Left side normal.

Urine from both kidneys contains a few coliform organisms and an occasional pus cell.

8-2-30. Cystoscopic examination.

I.C. left side 5 mins. good conc.
right " " " poor "

which did not improve.

Urine contains numerous pus cells and coliform organisms.

15-3-30. Lavage of right kidney pelvis with silver nitrate.

3-5-30. Feels very much better, urine sterile.

9-5-31. Another attack of right sided pain.

Cystoscopic examination.

I.C. left side 5 mins. good conc.
right " " " poor "

14-5-32.

L.P. 5-3-32.

3rd pregnancy.

14-5-32. No urinary symptoms. 10 weeks pregnant.

Cystoscopic examination.

I.C. left side 5 mins. good conc.
right " " " poor "

Urine contains an occasional pus cell, and numerous coliform organisms.

6-7-32. Cystoscopic examination.

Name Mrs B.

Age 23

Ward

Physician

Journal

Page

Date of Admission

7.3.28

Diagnosis

Temp.

Case no. 45.

24 Pregnancy

Pulse

Fundus

and/or

Albumen

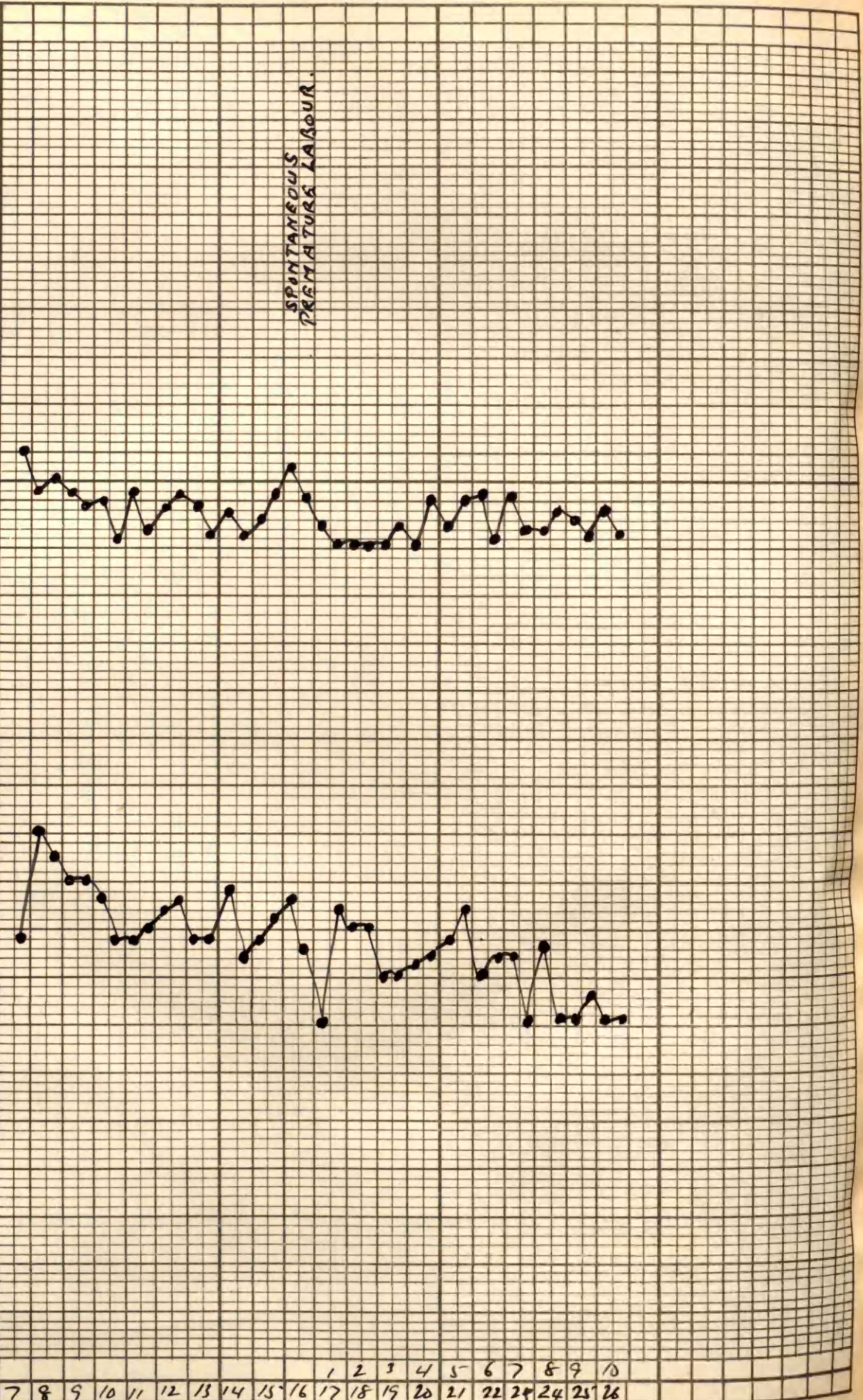
Bowels
Urine

107°
106°
105°
104°
103°
102°
101°
100°
99°
98°
97°
160
150
140
130
120
110
100
90
80
70
6
5
4
3
2
1

SPONTANEOUS
PREMATURE LABOUR.

Puerperium

Date



Name Mrs B

Age 24

Ward

Physician

Journal

Page

Date of Admission

Diagnosis

Temp.

Case no. 45

3rd Pregnancy.

Pulse

Fundus

and/or

Albumen

Bowels
Urine

107°

106°

105°

104°

103°

102°

101°

100°

99°

98°

97°

160

150

140

130

120

110

100

90

80

70

6

5

4

3

2

1

Puerperium

Date

16

17

18

19

20

21

22

23

24

25

26

27

28

29

30

1

2

3

4

5

6

September 1932

Cystitis

URETERAL
CATHETER
QT URETER

6-7-32. Cystoscopic examination.

I.C. left side 5 mins. good conc.
right " 12 " poor "

Urine contains only a few coliform organisms.

31-7-32. Sudden severe right sided pain and shivering attack. In bed at home until admission on

16-9-32. Wasting, sickness, jaundice. Temp. 100°, pulse rate 120.
28 weeks pregnant.

21-9-32. Cystoscopic examination.

I.C. left side 5 mins.
right " none in 15 mins.

Catheter passed into right ureter and left in position for several hours.

22-9-32. Intravenous pyelogram, fig. 120, the plate taken at 90 mins, shows enormous dilatation of the right calyces. Left tract is normal.

27-9-32. Uterine contractions have been marked for some days. Temp. and pulse rate elevated. Catheter inserted into right ureter and left in for 24 hours. Temp. and pulse rate fell immediately and patient felt better.

30-9-32. Uterine contractions have ceased.

23-10 -32. Patient is being sick. Membranes ruptured artificially, as now in 33rd week. Spontaneous delivery, child 5½ lbs alive.

6-11-32. Dismissed.

4-1-33. Feels well, no tenderness.

31-5-33. Well and has put on weight. No urinary symptoms but urine contains abundant pus cells and coliform organisms.

This patient had pyelitis with each of 3 pregnancies. Between pregnancies the urine is sterile at intervals and there is no stasis. At the 5th month in each pregnancy an acute exacerbation occurred and marked stasis is then found in the right urinary tract. The attacks showed no sign of becoming less severe as in case 44, and probably the treatment by ureteral drainage prevented the onset of labour at a time before the child was viable.

Name Mrs D.

Age 20

Ward _____

Physician _____

Journal _____

Page _____

Date of Admission

20.12.32

Diagnosis _____

Temp. _____

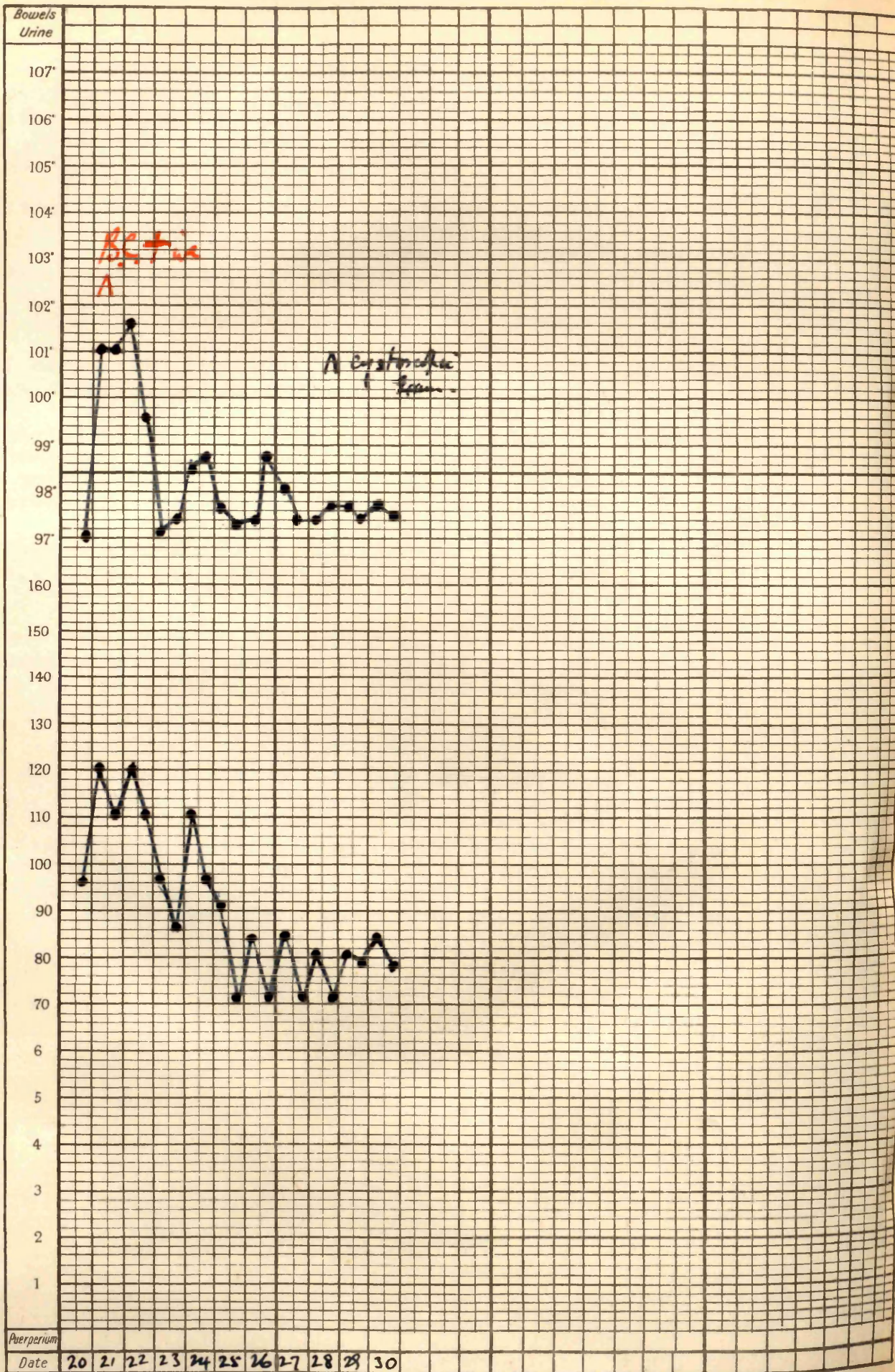
Case no. 46.

Pulse _____

Fundus _____

and/or

Albumen _____



Case sheet no.46.

Mrs.D.

aet.20

1st preg.

20-12-32. Admitted.

L.P.12-4-32.

36 weeks preg.

Present pregnancy. Well until 14 days before admission when she had "influenza". Slight right sided pain.

Examination. No anaemia. Slight pedema. In labour.

Spontaneous delivery after 12 hours, child alive, 4lbs

21-12-32. Severe cough, râles at right lung base.

26-12-32. Temp. settled. Occasional râles at base of right lung.

31-12-32. Dismissed.

Bacteriological and Urological Examination.

21-12-32. Urine contains no albumen, abundant pus cells and coliform organisms.

Blood culture gives growth of coliform organisms.

Vaginal discharge gives abundant growth of coliform orgs.

Sugar reactions of organisms isolated from -

Urine ++--+A
 +++++AC
 x +++++AC-+

Vagina. ++--+A
 +++++AC
 x +++++AC-+

Blood. ++--+A
 +++++AC
 x +++++AC-+

Faeces.1. ++--+A
 ++--+AC
 ++--+AC++

2. ++--+A
 +++++AC
 +++++AC++

3. ++--+A
 +++++AC
 x +++++AC++

23-12-32. Urine contains abundant pus cells and coliform organisms.

24-12-32. Vaginal discharge contains abundant growth of coliform organisms but no pus cells.

28-12-32. Cystoscopic examination. Congestion of trigone of bladder, orifices congested. No cystitis.

I.C. left side 4 mins. good conc.

right " " " conc. not quite so good as at left.

Catheter passed to right side and fairly large quantity of urine drained off.

Bladder urine sterile.

Right kidney urine contains a few leucocytes.

Name Mrs. H. Z.

Age 23

Weight

Physician

Journal

Reg

Date of Admission
21-1-33

Diagnosis

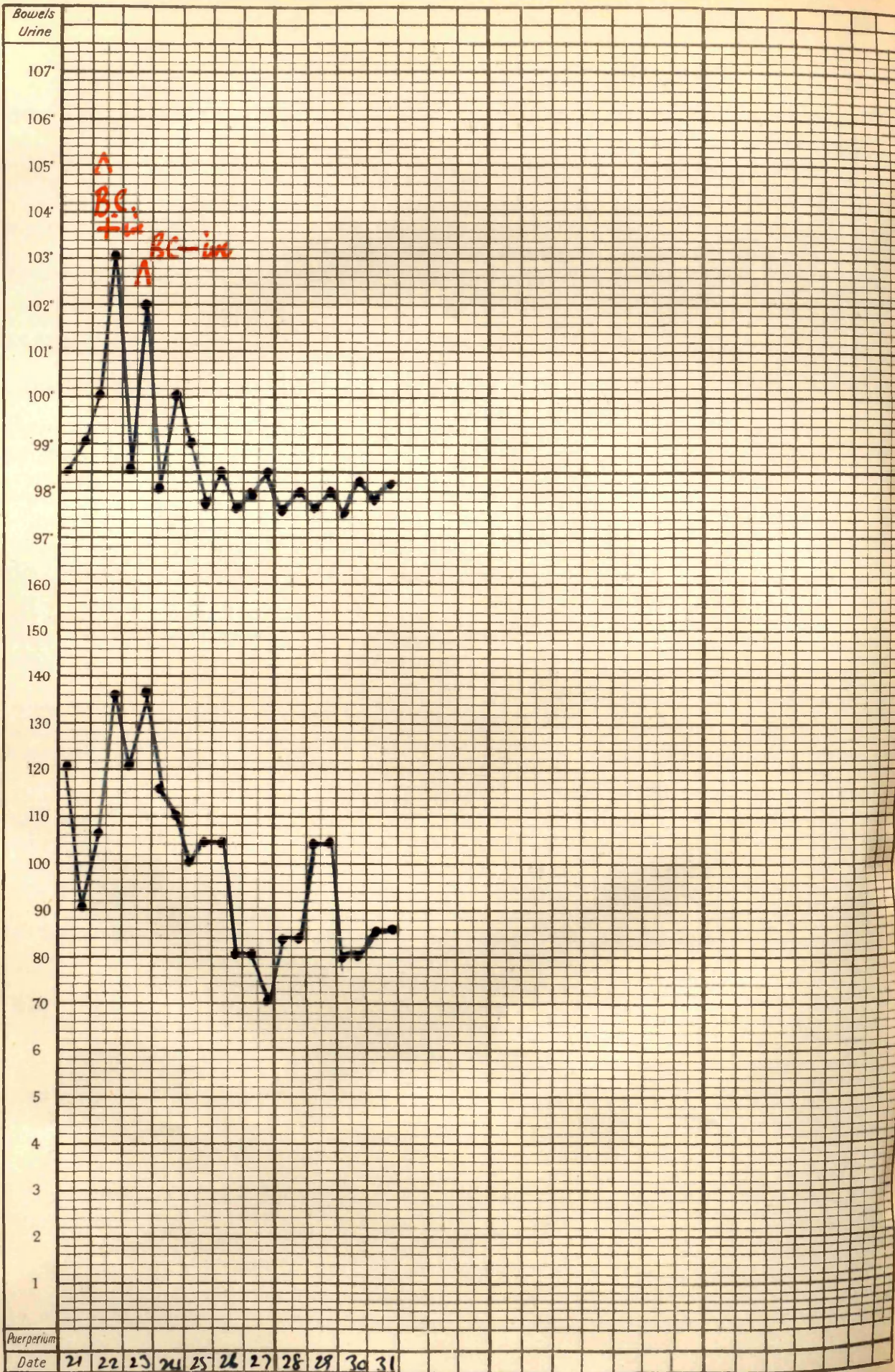
Temp

Pulse

Fundus

and/or

Albumen



Case sheet no.47.

Mrs. McL.

aet 23

3rd pregnancy

21-1-33. Admitted.

L.P. end of April, 1932.

37 weeks preg.

Obstetric history. 1st full time pregnancy, instrumental delivery, child alive, 8 lbs.

2nd abortion.

Present pregnancy. Well during pregnancy. Membranes ruptured 2 days before admission.

Examination. 2.15am. Cervix only 2-3 fingers dilated.

9pm. Version performed.

22-1-33. 1pm. Delivered.

2pm. Rigor. Temp. 105.4°

23-1-33. Feels well although temp. still high. No renal pain.

24-1-33. Lochia red and scanty but not offensive.

Bacteriology.

22-1-33. 2 hours after delivery. Blood culture gives growth of coliform organisms and streptococcus faecalis.

Vaginal swab shows a few coliform organisms and numerous Doederlein bacilli.

23-1-33. Blood culture sterile.

24-1-33. Urine contains abundant coliform organisms and Doederlein bacilli.

25-1-33. Vaginal swab shows a few Gram +ve cocci and coliform orgs.

27-1-33. " " " abundant pus cells and gram +ve cocci and a few gram-ve bacilli of coliform type. Culture gives a predominating growth of haemolytic streptococci and fairly numerous coliform colonies.

Urine contains abundant pus cells and coliform organisms.

14-2-33. Sugar reactions of organisms isolated from -

<u>Urine.</u>	++A+-AC	<u>Vagina</u>	++A+-AC (lactose fermented)
	++++-AC	(1).	++++-AC
	○ +++++-AC++		+++++AC-- X

(2). +--+AA (lactose not fermented)

+--+A

+--+AC-- X

<u>Blood.</u>	+--+AA
	+--+A
	+--+AC-- X

<u>Faeces.</u>	++A+AC
(1).	+++++AC
	+++++AC-- X

(2).	++A+-AC
	++++-AC
○	++++-AC++

The patient's serum agglutinated the organism in the blood up to a titre of 1/400 and the non-lactose fermenting organism in the vagina up to a titre of 1/100. The other organism from the vagina, the organism from the urine and both organisms from the faeces were not agglutinated.

Name Mrs T
 Age 31
 Ward _____
 Physician _____
 Journal _____
 Page _____

Date of Admission 3.11.32
 Diagnosis _____
 Temp. _____

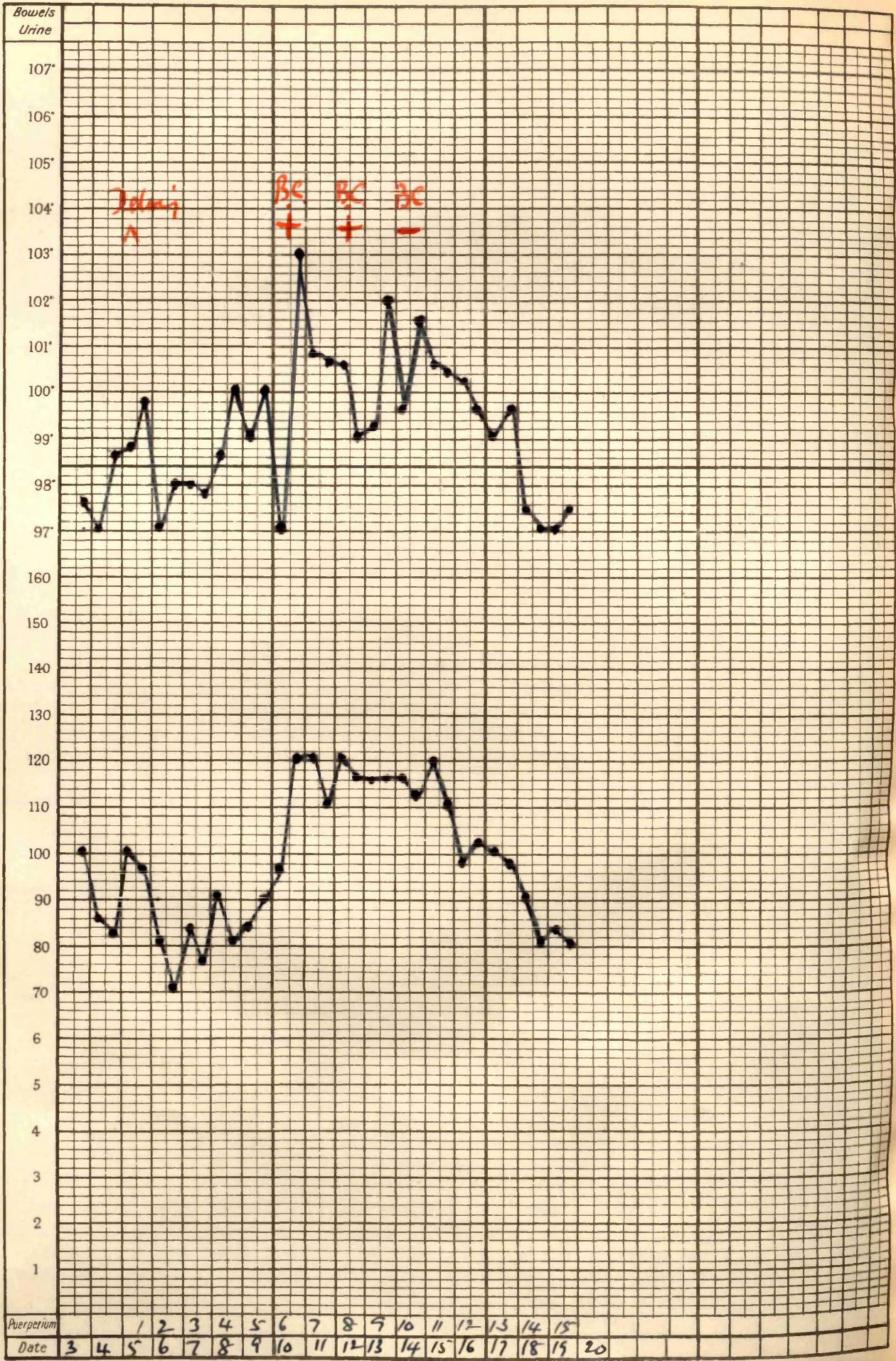
Case no 48.

Pulse _____

Fundus _____

and/or

Albumen _____



November.

Base sheet no.48. Mrs.T. aet.31 1st pregnancy.

3-11-32. Admitted. L.P. 16-1-32. 41 weeks pregnant.

Present pregnancy. Well during pregnancy. Swelling of feet for 6 months. Sent in as delayed labour.

Examination. In labour, tonic contractions of uterus, os only 2 fingers dilated. Head fixing. Healthy woman. Oedema very slight.

5-11-32. Delivery completed by low forceps. Perineal and vaginal tears repaired. Child difficult to resuscitate, 8 $\frac{3}{4}$ lbs. 42 hours in labour.

6-11-32. Catheterised and 36 ozs of urine obtained.

7-11-32. Marked distension of abdomen.

8-11-32. Pain in both kidney regions.

10-11-32. Tender over both kidneys. Severe dysuria. Lochia normal.

12-11-32. No tenderness over kidneys.

10-11-32 and 12-11-32. Blood culture gave growth of coliform organisms.

13-11-32. Cystoscopic examination. Bladder contains a large quantity of foul smelling urine. Bladder wall very injected, ureteral orifices normal.

I.C. left side 8 mins.

right " none in 12 mins.

Catheter inserted into each ureter. On the right side I.C. tapped above the pelvic brim. Urine from both kidneys heavily infected.

Urea concentration of right kidney urine is 1.14%

" " " left " " " 1.51%.

14-11-32. Blood culture sterile.

21-11-32. Allowed up.

25-11-32. Cystoscopic examination. I.C. left side 5 mins.

right " none in 7 mins.

I.C. appeared at right side after abdominal massage.

Therefore still atony of right ureter.

Bladder urine still contains numerous pus cells and coliform organisms.

Sugar reactions of organisms isolated from -

Urine. ++-++AC++ X Vagina ++-++AC++ X

Blood. ++-++AC++ X Faeces. (1). ++-++AC++ X
(2). ++-+-AC--

18-1-34.

2nd pregnancy.

18-1-34. 5months pregnant. Feels well. Urine sterile.

In this case the renal symptoms were more prominent than usual probably due to stasis in the ureters. The organism infecting the blood and urine probably came from the bowel.

Name Munkh CK

Age 25

Word _____

Physician _____

Journal _____

Page _____

Date of Admission

23.7.31

Diagnosis _____

Temp. _____

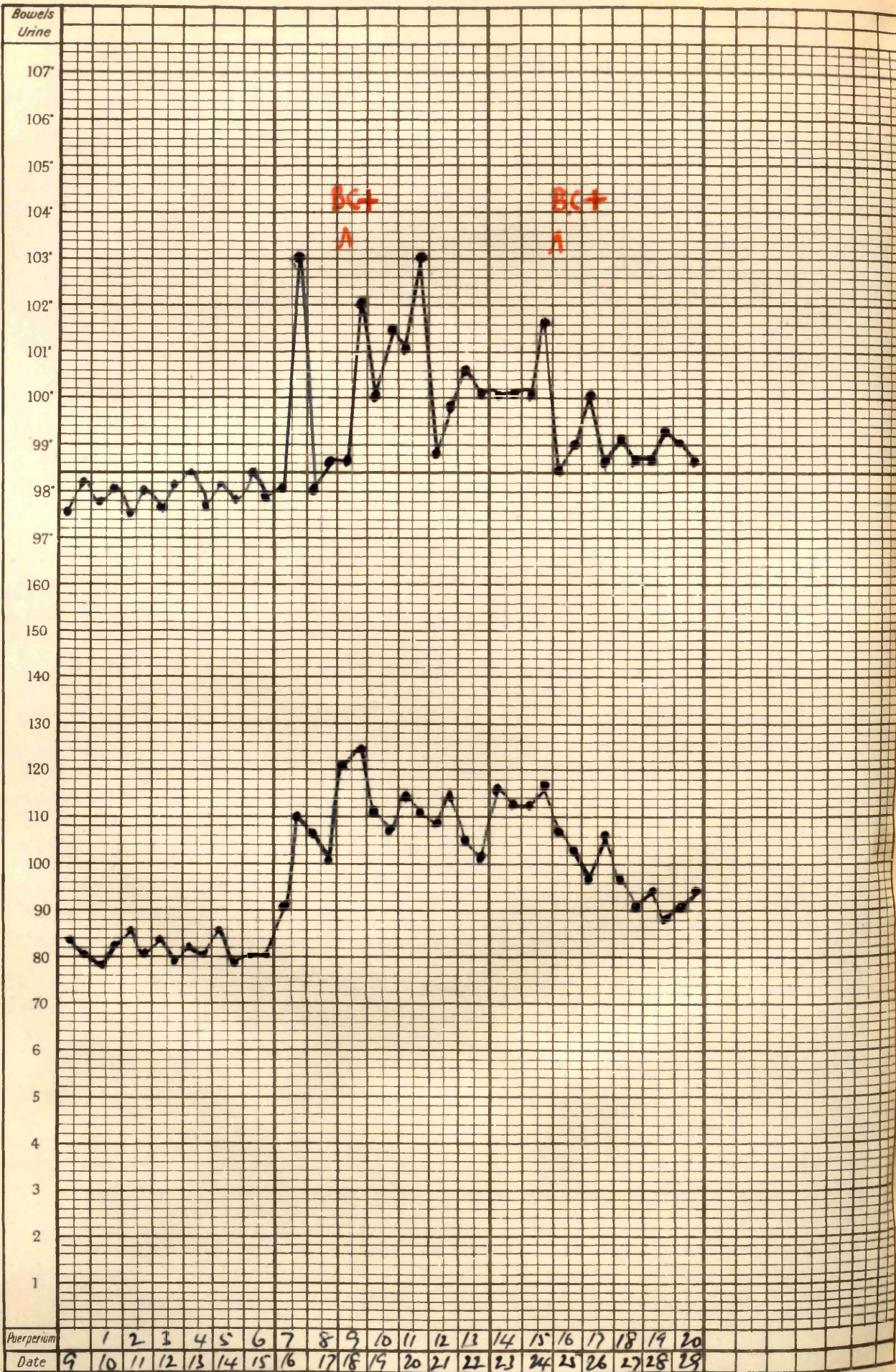
Pulse _____

Fundus _____

and/or

Albumen _____

Case no 49.



Case sheet no.49. Mrs.McK. aet 29. 3rd pregnancy.

23-7-31.Admitted. L.P.21-10-30. 40 weeks pregnant.

Obstetric history. 1st normal full time pregnancy,instrumental delivery ,child alive.

2nd normal full time pregnancy,breech stillborn.

Present pregnancy. Well. Urine clear. Admitted because of obstetric Examination. No abnormality. Afebrile. history.

9-8-31. Forceps delivery after a long labour,child $9\frac{3}{4}$ lbs.alive. Slight laceration.

11-8-31. Catheterised 52 ozs. withdrawn.

14-8-31. Passed urine spontaneously for first time since delivery. No residual urine in bladder.

16-8-31. Rigor.

18-8-31. No complaint although temp. still elevated.

19-8-31. Blood culture gives pure growth of coliform organisms. Urine contains abundant pus cells and coliform organisms.

25-8-31. Blood culture gives pure growth of coliform organisms.

3-9-31. Temp. has been normal for 6 days,allowed up.

The organism isolated from the urine and the one from the blood give the same sugar reactions.

10/2/34. Feels well apart from right sided pain. Urine contains a haze of albumen but is sterile.

Name Mrs D.
 Age 25
 Ward _____
 Physician _____
 Journal _____
 Page _____
 Date of Admission 22.3.33
 Diagnosis _____
 Temp. _____

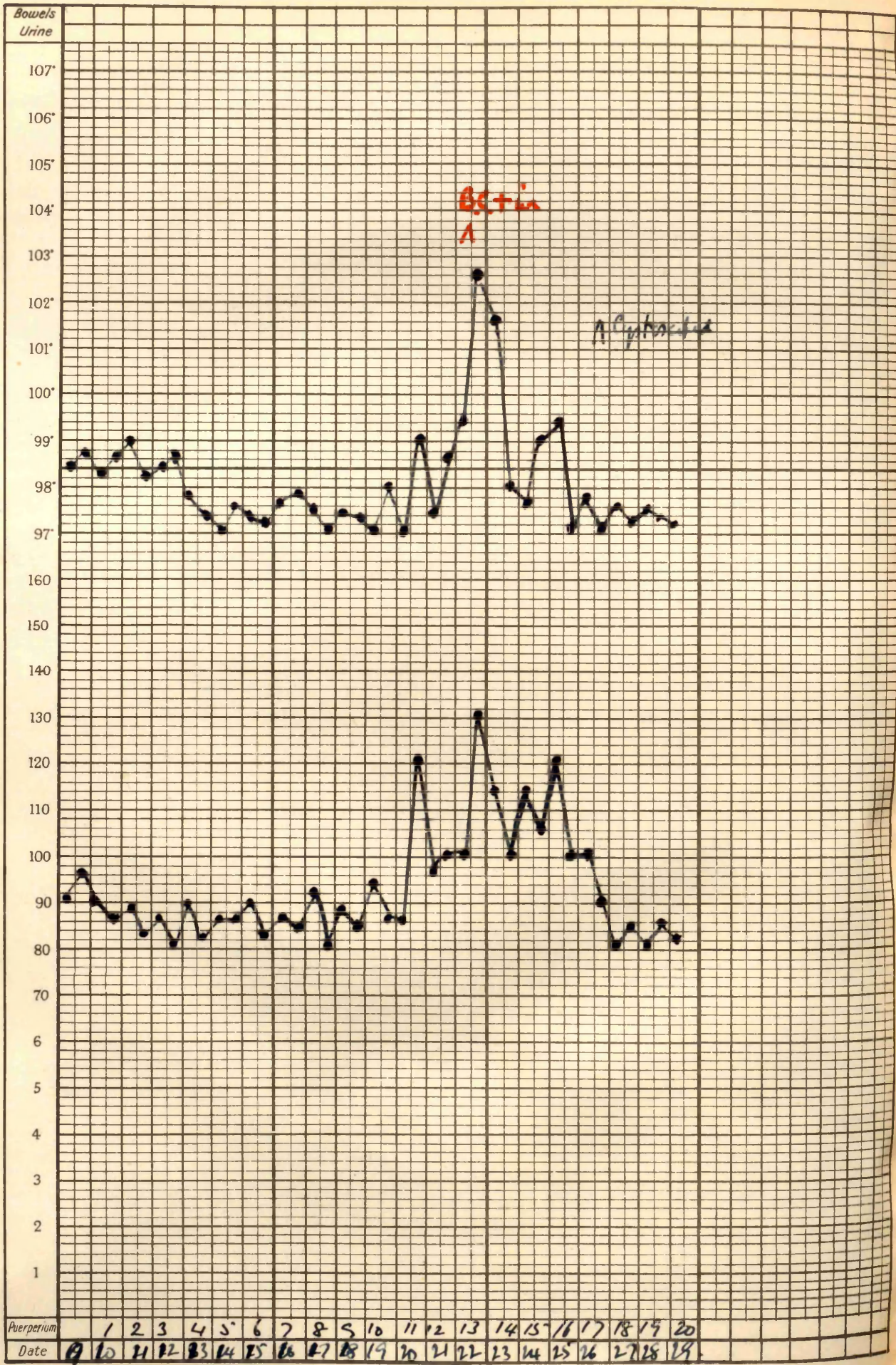
Case no. 50

Pulse _____

Fundus _____

and/or

Albumen _____



Case sheet no.50. Mrs.D. aet 25 4th pregnancy.
 22-3-33. Admitted. L.P.18-8-32. 31 weeks pregnant.

Obstetric history. 1st miscarriage at 4 months.
 2nd " " 6 "
 3rd normal full time pregnancy, alive.

Present pregnancy. 2 days before admission dimness of vision,
 sleeplessness and poor appetite.

Examination. No oedema, or anaemia. Afebrile. B.P.200/120.

Urine sterile, but contains albumen.

9-4-33. B.P. remains high and Esbach 2 parts. Went into labour
 spontaneously. Spontaneous delivery, child $3\frac{1}{2}$ lbs, alive.

18-4-33. Temp. and pulse rate normal. B.P.230/150.

21-4-33. Pain and tenderness in right kidney region.

22-4-33. Temp. 103°, pulse rate 130.

Blood culture gives growth of coliform organisms.

26-4-33. Cystoscopic examination.

Bladder normal.

I.C. left side 5 mins. fair conc.
 right " " " " "

Bladder urine contains abundant pus cells and coliform
 organisms.

Urine from Rtkidney contains numerous pus cells and a few
 coliform organisms.

Urine from Lt.kidney contains a few pus cells and coliform
 organisms.

Temp. and pulse rate have now settled.

29-4-33. Urine now sterile.

Sugar reactions of organisms isolated from -

Urine. +++-AC-+ ✕ Blood. +++-AC-+ ✕

Vagina. +++-AC-+ ✕ Faeces.(1). +-+---+
 (2). +-++AC++

An identical organism was therefore isolated from urine,
 vagina and blood but not from the faeces.

Name Mrs J.

Age 19

Weight _____

Physician _____

Journal _____

Page _____

Date of Admission
21.4.33

Diagnosis _____

Temp. _____

Case no. 51

Pulse _____

Fundus _____

and/or

Albumen _____

Bowels
Urine

107°

106°

105°

104°

103°

102°

101°

100°

99°

98°

97°

160

150

140

130

120

110

100

90

80

70

6

5

4

3

2

1

Puerperium

Date

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

21 22 23 24 25 26 27 28 29 30 1 2 3 4 5 6 7 8 9 10 11

BC
-ve

BC
+ve

BC
+ve

BC
-ve

Cystocele
A / Stan.

Case sheet no.51. Mrs.J. aet.19. 1st pregnancy.

21-4-33. Admitted~. L.P. 20-7-32. 39 weeks pregnant.

Present pregnancy. Well during pregnancy. In labour 24 hours before admission.

Examination. Not exhausted, pains infrequent, cervix almost fully dilated, membranes intact.
12 hours later, difficult forceps delivery, child 7lbs alive. Moderate postpartum haemorrhage.

22-4-33. Temp. 100°; pulse rate 110.

Blood culture sterile.

Urine sterile.

29-4-33. Rigor, temp. 103°, no other symptoms.

Blood culture gives growth of coliform organisms.

2-5-33. Blood culture gives growth of coliform organisms.

4-5-33. Temp. still elevated but blood culture sterile.

6-5-33. Cystoscopic examination.

Bladder injected and filled with debris. I.C. left side 4 mins. good conc.

right " " " " "

Bladder urine contains abundant pus cells and coliform orgs.

R.kidney " sterile.

L. " " contains a few coliform organisms.

Daily bladder lavage ordered.

10-5-33. Urine contains only an occasional coliform organisms.

Sugar reactions of organisms isolated from -

Urine. +++++AC-+X Vagina +++++AC-+X

Blood. +++++AC-+X Faeces. +++++AC-+X

In this case there was no stasis in the ureters but the bladder was not being emptied efficiently. The urinary infection cleared up very quickly when bladder lavage was instituted.

Bowels
Urine

Name Mrs D

Age 36

Ward

Physician

Journal

Page

Date of Admission
11.6.32

Diagnosis

Temp.

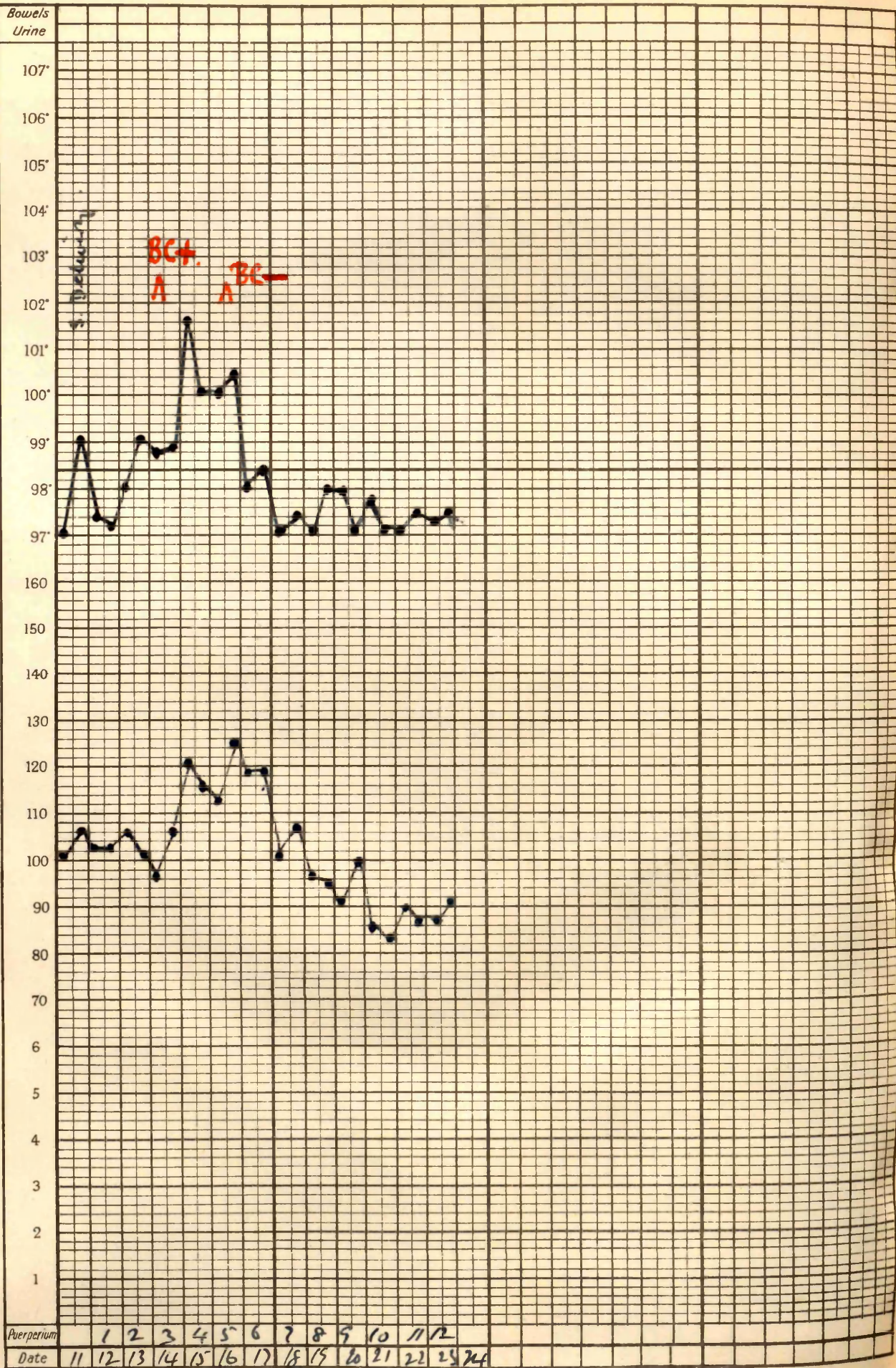
Case no. 52.

Pulse

Fundus

and/or

Albumen



Time.

Case sheet no.52. MrsD. aet.36. 6th pregnancy.
 11-6-32. Admitted. L.P. 15-8-31. 43 weeks pregnant.

Obstetric history. 5 normal full time pregnancies. Pain in left side for several years.

Present pregnancy Well during present pregnancy. Admitted in labour.

Examination. No abnormality detected except that the urine contains abundant pus cells and coliform organisms.

11-6-32. Spontaneous delivery, child alive, $7\frac{3}{4}$ lbs.

14-6-32. Rigor, temp. 104.6° .

Blood culture gives growth of coliform organisms.

15-6-32. Tender over left kidney and profuse offensive lochia.

16-6-32. Temp. still elevated and lochia still offensive.

Blood culture sterile. Intrauterine glycerine given.

17-6-32. Temp. settled. .

25-6-32. Dismissed.

Sugar reactions of organisms isolated from -

Urine before delivery X+++--AC-+

after delivery X+++--AC-+

Blood. X+++--AC-+ Vagina. X+++--AC-+ Faeces. ++++AC++

An antiserum was prepared against the organism from the urine before delivery and it agglutinated all the organism from the various sources except the faeces, up to the same titre of 1/1600.

26-12-34. Still complains of pain in the left side. Urine sterile.

In this case the organism in the urine before delivery was probably the source of the infection of the blood and uterus in the puerperium. The pyrexia was probably partly due to invasion of the blood stream and partly to infection of the uterine cavity .

Name Mrs P.
 Age 33
 Ward _____
 Physician _____
 Journal _____
 Page _____
 Date of Admission 20.1.31
 Diagnosis _____
 Temp _____

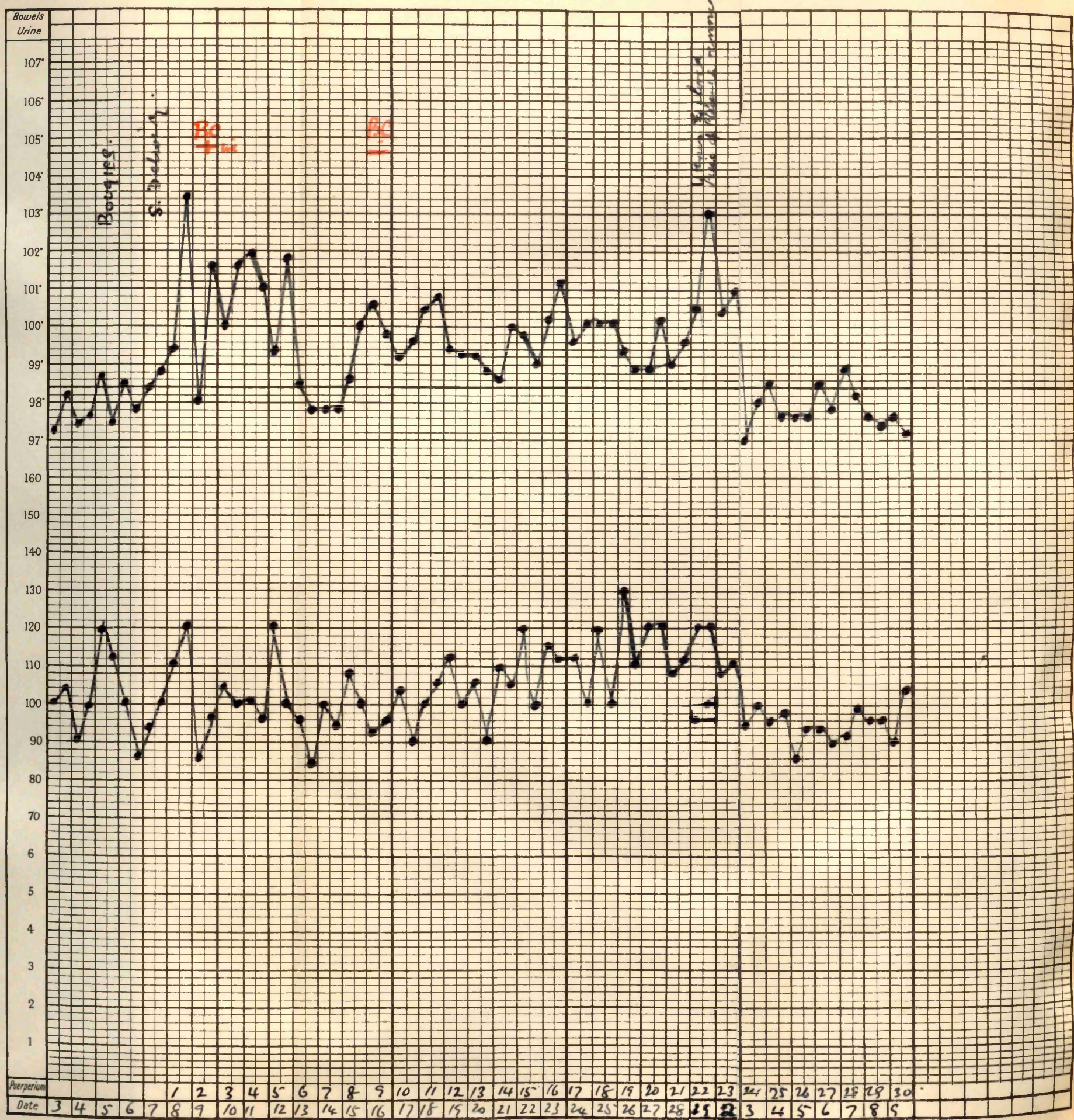
Case no. 53

Pulse _____

Fundus _____

and/or

Albumen _____



Case sheet no.53. Mrs.P. aet.33. 4th pregnancy.

20-1-31. Admitted. L.P.3-5-30. 37 weeks pregnant.

Obstetric history. 3 normal full time pregnancies.

Present pregnancy. Has not been well since end of 5th month, swelling of feet, headaches, breathlessness, anaemia. Urine sterile.

Examination. Marked oedema of both legs, anaemia, B.P.230/150.

Temp. normal, pulse rate 90-100. Esbach 2 parts.

25-1-31. Bougies for induction of labour unsuccessful.

5-2-31. Bougies repeated.

7-2-31. Spontaneous delivery. 8½lbs. alive

8-2-31. Rigor, temp. 103°, pain in left kidney region.

9-2-31. Blood culture gives growth of coliform organisms.

14-2-31. Temp. and pulse settled.

16-2-31. Temp. 101°. Blood culture sterile. Severe tenderness again present in left kidney region.

Urine contains numerous pus cells and coliform organisms.

Vaginal swab gives growth of coliform organisms.

25-2-31. Tenderness gone from kidney region. Patient thinner and more anaemic. Temp. swinging.

Cystoscopic examination. No cystitis.

I.C. 12 mins. left side poor conc

" " right " " "

Bladder urine contains a few pus cells and coliform orgs.

R.kidney urine sterile.

L. " " contains " " " " " " "

Urinary infection does not seem sufficient to account for the persistence of the pyrexia.

1-3-31. Uterus explored and piece of placenta removed.

4-3-31. Temp. and pulse rate now settled.

16-3-31. Dismissed. Urine still contains pus cells and coliform orgs.

10-2-34. General health poor; urine has no albumen and is sterile.

Name Mrs W

Age 29

Ward _____

Physician _____

Journal _____

Page _____

Date of Admission

29.6.32

Diagnosis _____

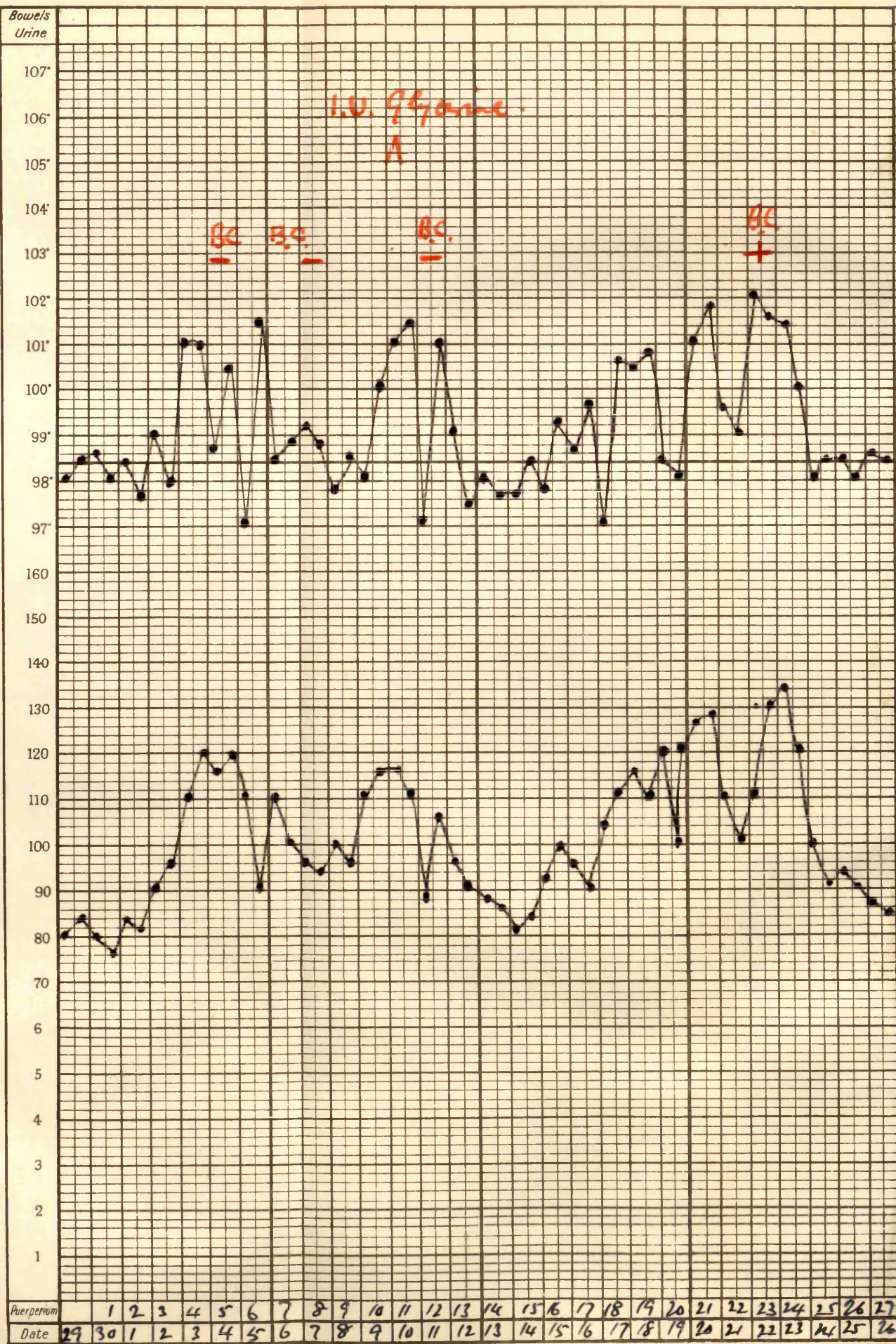
Temp. _____

Pulse _____

Fundus _____

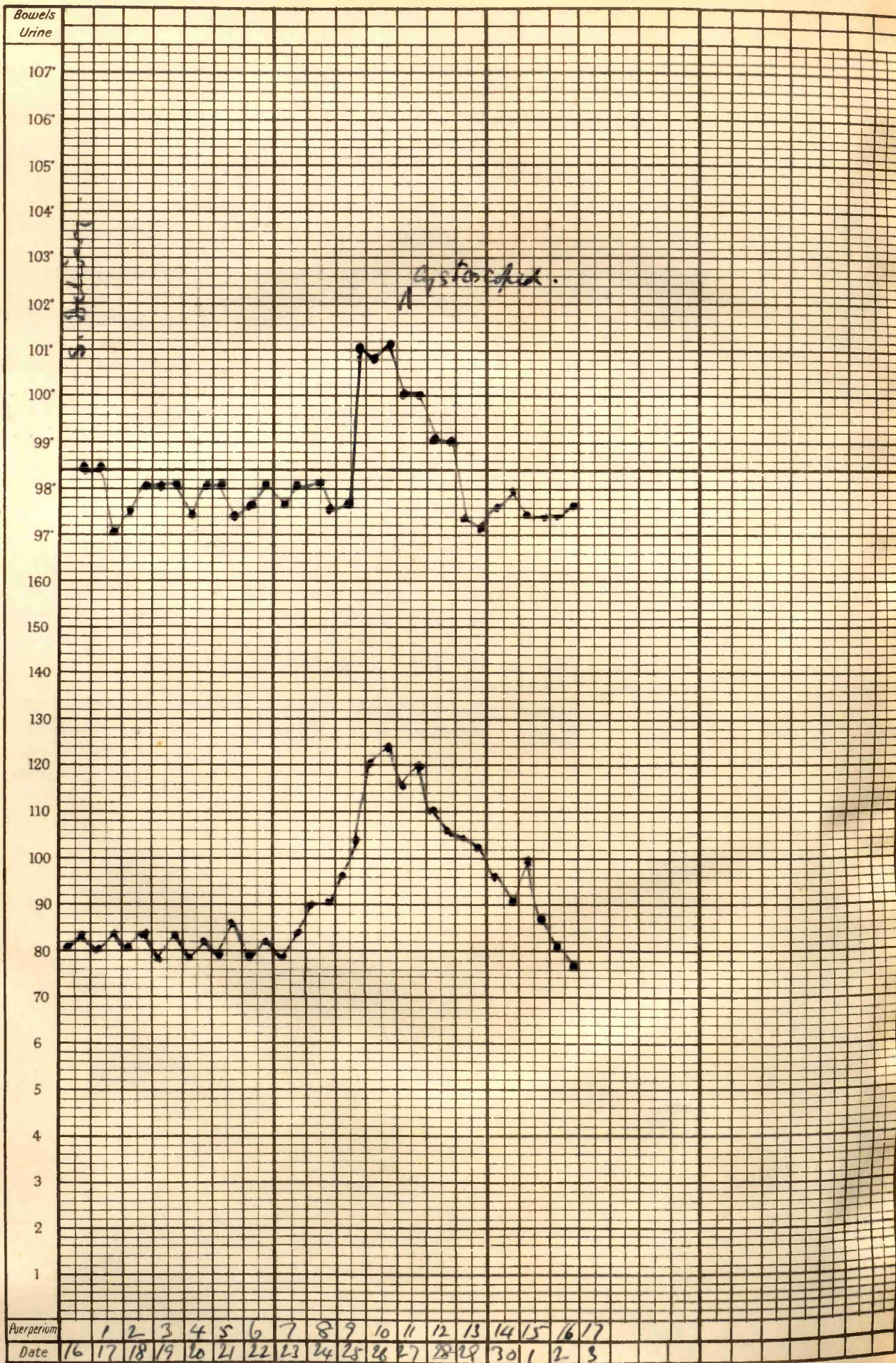
and/or

Albumen _____



Present pregnancy. Not well during pregnancy, vomiting throughout.
Admitted in labour.
Delivered almost immediately. Manual removal
of placenta.

3-7-32. Temp. 101°, pulse rate 120. Profuse foul smelling lochia.
4-7-32. Blood culture sterile.
Urine contains abundant pus cells and coliform organisms.
Vaginal swab gives pure growth of haemolytic streptococci.
7-7-32. Blood culture sterile.
11-7-32. Glycerine treatment fourhourly.
12-7-32. Blood culture sterile.
14-7-32. Temp. and pulse rate settled.
16-7-32. Temp. slightly elevated, pain in back.
19-7-32. Tender over right kidney.
22-7-32. Temp. 103°, urine sterile.
23-7-32. Blood culture gives growth of coliform organisms.
27-7-32. Urine sterile. Temp. and pulse rate settled.
8-8-32. Oedema of left leg, which subsided in a few days.
15-8-32. Dismissed.
Sugar reactions of organisms isolated from
Blood. +---+---+ Faeces. (1). ++--+AC--
(2). ++++--AC--
(3). +++++AC++



Examination. No anaemia, marked oedema of legs. B.P. 150/100.
Urine sterile. Contains a faint trace of albumen.

27-4-32. Cystoscopic examination. Cystitis.

I.C. left side 9 mins. poor conc.
right " " " good "

Left kidney urine contains a few pus cells and coliform organisms.

Urea concentration bladder urine	1.9%
" " R.kidney "	2.675%
" " L. " "	0.625%.

Sugar reactions of organisms from

Urine ++-++AC++ Vagina. ++-++AC++

Faeces. (1). +A++-AC+-

(2). $++-+-AC+-$

Name Mrs B.

Age 26

Ward

Physician

Journal

Page

Date of Admission

27.8.32

Diagnosis

Temp.

Case no. 56

Pulse

Fundus

and/or

Albumen

Bowels
Urine

CRANIOLOGY
MANUAL - REMOVAL
OF CALCULI

107°
106°
105°
104°
103°
102°
101°
100°
99°
98°
97°
160
150
140
130
120
110
100
90
80
70
6
5
4
3
2
1

BC

BC

Puerperium

Date

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14

Case sheet no. 56. Mrs.B. aet 26 1st pregnancy.

27-8-32. Admitted. L.P. 30-11-31 39 weeks pregnant

Present pregnancy. Well during pregnancy. Membranes ruptured for 48 hours before admission.

Examination. Well nourished, anaemic, face presentation, cervix 3 fingers dilated. *Urine sterile.*
9 hours later rigor, temp. 101°,
4 hours later, craniotomy and manual removal of placenta.

29-8-32. Temp. 101°, pulse rate 120. Pain over uterus and over both kidneys. Blood culture sterile.

1-9-32. Temp. and pulse rate settled. Abdomen still tender. Urine contains abundant pus cells, coliform organisms and haemolytic streptococci. Cervical swab gives growth of numerous coliform colonies and a few haemolytic streptococci.

4-9-32. Pelvic cellulitis and salpingo-oophoritis palpable on left side.

11-9-32. Temperature 100° and pulse rate 110. Blood culture sterile. Urine still contains abundant coliform organisms and streptococci.

14-9-32. Fluctuant mass in left iliac fossa which subsided.

2nd pregnancy.

L.P. 12-3-33.

4-10-33. 30 weeks pregnant. Feels well. No urinary symptoms.

Cystoscopic examination. No cystitis.

I.C. left side 5 mins. good conc.
right " " " " "

Bladder urine contains numerous pus cells and coliform organisms and a few streptococci.

R. kidney urine contains a few pus cells and coliform orgs.

15-11-33. Admitted because of slight bleeding.

23-11-33. Dismissed. Bleeding only slight and afebrile while in hospital.

5-12-33. Admitted very collapsed due to bleeding from a placenta praevia from which she died.

Post mortem examination showed that death was due to haemorrhage. Each kidney weighed 8 ozs. The right kidney pelvis and ureter showed moderate dilatation down to the pelvic brim. The left tract was undilated. Sections from the right kidney showed areas of healed pyelonephritis. In some areas the lesion was subacute. The kidney pelvis and ureter on the right side showed oedema and lymphocytic infiltration. Left kidney and urinary tract normal.

This case shows that suppurative conditions of the kidney can occur in the puerperium with very little disturbance of temp. and pulse rate. The second pregnancy shows that infection of the upper urinary tract can be present without symptoms due to the fact that no stasis developed to cause an exacerbation.

Name Mrs W.

Age 31

Weight

Physician

Journal

Page

Date of Admission

15-2-34

Diagnosis

Temp

Pulse

Fundus

and/or

Albumen

Bowels
Urine

107°

106°

105°

104°

103°

102°

101°

100°

99°

98°

97°

160

150

140

130

120

110

100

90

80

70

6

5

4

3

2

1

Puerperium

Date

1

2

3

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MARCH.

Case sheet no. 577 Mrs. W. aet 31 3rd pregnancy.

15-2-34. Admitted. L.P. 10-4-33. 42+ weeks preg.

Obstetric history. 1st normal full time pregnancy - instrumental delivery.
2nd miscarriage at 6 months due to pyelitis.

Present pregnancy. Pain in right kidney region and in right iliac fossa throughout whole pregnancy.
Admitted in labour.

Examination Temp. and pulse rate normal. Very stout but no oedema
Occiput posterior, forceps delivery, slight tear.
Child 8 lbs alive.

16-2-34. Pain in right side - feels very weak.

17-2-34. Rigor, temp. 101°, severe pain in right kidney region.
Followed drastic purgation. Blood culture growth coliform orgs.

18-2-34. Rigor, very excitable.

19-2-34. Rigor, blood culture sterile.

Urine contains abundant pus cells and coliform organisms.

Vaginal swab gives pure growth of coliform organisms.

23-2-34. Cystoscopic examination.

I.C. left side 5 mins. good conc.
right " " " " "

Bladder urine heavily infected with coliform organisms.

Both kidney urines contain a few coliform organisms, and a few pus cells.

No sign of uterine sepsis.

28-2-34. Tenderness in left costovertebral angle.

3-3-34. Temp. 102°, pulse rate 130.

Cystoscopic examination.

I.C. left side 5 mins.
right " " "

Catheter passed into left ureter and 10 ccs of acriflavine injected caused pain exactly similar to that complained of.

4-3-34. Residual urine 6 ozs.

9-3-34. Has been catheterised daily and residual urine is only 1/2 oz

10-3-34. Urea concentration test highest reading 2.3%

16-3-34. Dismissed.

Sugar reactions of organism isolated from -

Urine ++A++AC++X Vagina (1). ++A++AC++X
(2). +++++A++

Blood. ++A++AC++X Faeces. (1). ++A++AC++X
(2). ++--AC--
(3). A-----++

On 12 -3 -34, blood was taken off for agglutination test and the organisms with the same sugar reactions were all agglutinated up to 1/200, which was as far as the test was carried. Vagina (2) and faeces (2) and (3) were not agglutinated.

In cases where the urine is infected before delivery pyrexia in the puerperium of urinary origin usually occurs early as in this case.

Case sheet no.58. MrsR. aet 23 3rd pregnancy.

17-7-31. Admitted. L.P. 10-2-31 23 weeks pregnant.

Obstetric history. 1st miscarriage at 6½ months.
2nd premature delivery at 7½ months, child lived for 1 week.
On both occasions felt well until labour began.

Present pregnancy. Well but easily tired:

Examination. Slight anaemia, afebrile, pulse rate normal.

17-7-31. Cystoscopic examination. No cystitis. Left ureteral orifice congested and projects. I.C. left side none in 12 mins.
right " 9 mins. fair conc.

Intravenous pyelogram, fig. 40, shows marked dilatation of calyces and kidney pelvis on left side with kinking and dilatation of the ureter. Right urinary tract also dilated but to a less degree.

22-7-31. Cystoscopic examination in 3rd hour of urea concentration test.

Bladder urine	before urea	1.02%
" "	1 hour after	1.29%
" "	2 hours "	1.84%
R.kidney "	2¼ " "	2.108%
" " "	2½ " "	1.859%
L.kidney "	2¼ " "	1.558%
" " "	2½ " "	1.614%

At 2½ hours after urea was given the concentration in the urine from the left kidney has not yet reached its maximum while that in the urine from the right is decreasing.

5-8-31. Cystoscopic examination. I.C. none at either side in 14 mins.

8-8-31. Uterine contractions - morphia given.

9-8-31. Complete miscarriage.

21-8-31. Intravenous pyelography failed to give a satisfactory shadow of either urinary tract. One of the plates is shown in fig. 41 and only an indistinct shadow of both kidney pelves is seen.

22-8-31. Urea concentration test highest reading 3.25% in 2nd hour.

21-9-31. Retrograde pyelogram, fig. 42, shows that there is still considerable dilatation of the calyces and kidney pelves on both sides, and narrowing of the ureteropelvic junction.

28-9-31. Cystoscopic examination. I.C. left side 5 mins.
right " " "

Although there is dilatation, there is therefore no delay in excretion.

1 year later this patient had cystoscopic examinations before and after several menstrual periods. On each occasion before the period the action of the left ureter was found to be very irregular, intervals of 2 - 3 minutes sometimes occurring between contractions. After the period contractions occurred much more regularly and were more vigorous. It is possible that the ureteral musculature is very poor and is unduly influenced by endocrine changes. Whether the repeated miscarriages occurred as a result of the interference with kidney function brought about by the dilatation which accompanied pregnancy is difficult to say.